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ABSTRACTS

of recent published material on Soil and Water Conservation

Number 22

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"ABSTRACTS of recent published material on Soil and Water Conservation" are abstracted by Charles B. Crook in the Soil and Water Conservation Research Division of the Agricultural Research Service.

They are issued at irregular intervals, and their purpose is to bring together a summary of current published information about soil and water conservation for ready reference of those actively engaged in soil and water conservation work. Reprints of abstracted articles are generally not available in the Division. Requests for reprints should be sent to authors or institutions--addresses have been appended to abstract.

The classification of articles follows the table of contents used for the "Soil and Water Conservation Research Needs" presented by the Soil Conservation Service. Mr. Crook is abstracting completely enough so article need not be consulted unless details are required. In case of a review, or a "how-to-do-it" article then the abstract is not complete. Abstracted articles are not editorialized and the language of the author is used wherever possible. In foreign articles, the units of measure are converted to usual American units. Tables are included where they help to present the information. When an entire number of a publication is devoted to reviewing one subject then the entire publication is abstracted as one article giving title and authors of each paper included in the publication. Abbreviations of journals and addresses are the standard ones set up by the U.S.D.A. Library in U.S.D.A. Misc. Pub. 765, July, 1958.

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WATERSHED ENGINEERING

Watershed Development

Barnett, H. T. THE PRIDE OF CROSS COUNTY. Land & Water Contracting. 2(12): 9-10. 1960.

In 1958, a 5.2-inch rain, falling in two hours, put as much as 14 inches of floodwater in downtown stores at Wynne, Arkansas, a town of 5,000.

Today two floodwater retarding dams built just above the city limits protect the town from floodwaters from Crowleys Ridge. With this water held back, streams can carry away the flow from city streets and storm sewers, relieving the threat of flood. Only the most severe and unusual storm can force water around the open emergency spillways above the flood pool level.

This is but part of the watershed protection and flood prevention project planned for the 39,680-acre Caney Creek watershed in Cross County, Arkansas. Some 11,900 acres of hill land are receiving conservation treatment and special measures for the control of severely gullied areas.

SCS, USDA, Forrest City, Ark.

Packer, P. E. WATERSHED MANAGEMENT PROBLEMS IN THE NORTHERN ROCKY MOUNTAIN REGION. Intermountain Forest and Range Expt. Sta. Res. Paper 57, 28 pp. 1959.

The high priority problems of watershed management on forest and range lands of the upper Columbia and Missouri River drainages are delineated. To evaluate the relative importance of these problems it is necessary to understand their scope and the nature of the factors that influence them. This requires a thorough knowledge of: (1) Pertinent facts about the existing water situation; (2) the nature of water problems in these two basins; and (3) the manner by which the physical features and resource uses of the region bear on these water problems. This report is a condensed summary of a more detailed watershed management research problem analysis recently developed for this area.

A review of watershed characteristics reveals pertinent facts and relationships regarding watershed conditions in the Northern Region and was summarized as follows: (1) Average annual precipitation of about 29 inches on Columbia Basin lands is almost double the 15 inches received by lands in the Missouri Basin. (2) Three-fourths or more of the annual precipitation in the Columbia Basin falls as snow. In the Missouri Basin, snow accounts for only about one-half of the annual precipitation. (3) About one-half of the Columbia Basin's average annual precipitation, or approximately 14 area inches of water, runs off as streamflow. In contrast, only about one-sixth of the Missouri Basin's annual precipitation, or approximately 2.5 inches, appears as streamflow. From two-thirds to four-fifths of the annual discharge of both basins occurs between March and July. (4) Evapotranspiration causes loss of only about one-half of the precipitation in the Columbia Basin, but about five-sixths of the precipitation in the Missouri Basin. (5) Nearly all the soils are highly erodible when bared by disturbance. They are shallow and have low storage capacity on the steep slopes. (6) A high proportion of the forest cover is mature or near-mature and probably exerts close to its potential for flood control and consumptive water use. And (7) a large percentage of range land is in unsatisfactory condition for controlling storm runoff and soil erosion.

The numerous problems of watershed management encountered in the Northern Region can be classified into the following three general groups: (1) Maintaining the normal hydrologic functioning of watersheds under use without creating conditions that lead to a rapid and severe state of deterioration; (2) restoring damaged watersheds; and (3) improving water yields by increasing streamflow or by altering its time of delivery to meet seasonal demands for water more satisfactorily.

Two general kinds of information about watershed management are needed to provide solutions to these problems. One is quick development of protection criteria or guides for such activities as road building, logging, and grazing. The other is development treatments on streamflow and soil stability characteristics of forest and range watersheds.

Intermountain Forest and Range Expt. Sta., FS, USDA, Ogden, Utah.

Coleman, W. J. WATERSHED ORGANIZATION APPRAISAL EAST WILLOW CREEK PILOT PROJECT IN MINNESOTA. U.S. Dept. Agr., Agr. Res. Serv. CU 285, 18 pp. 1960.

How the East Willow Creek Watershed Project was organized and established is described and the functions that were performed by various organizations, agencies, and individuals are given. The report deals primarily with the structure of the watershed government and the relationships of its elements with respect to the watershed protection objectives. The survey was limited to those aspects of organization and administration that dealt with the planning and construction of works of improvement contained in the watershed project.

ARS, USDA, Inform. Div., Washington 25, D. C.

Bailey, R. W., and Copeland, O. L., Jr. LOW FLOW DISCHARGES AND PLANT COVER RELATIONS ON TWO MOUNTAIN WATERSHEDS IN UTAH. In Commission of Surface Waters. International Assoc. Sci. Hydrol. 51: 267-278. 1960.

Twenty-two years of streamflow records provide a basis for comparing the behavior of low flow discharges from two adjacent mountain watersheds that produced damaging mud-rock floods in 1930 following destruction of vegetation on the headwater lands. Vegetation was restored on the depleted and eroded areas by contour trenching and reseeding prior to the start of streamflow records.

The annual regime of discharge from both watersheds is characterized by a rapid rise shortly after the beginning of snowmelt late in March, a brief period of maximum discharge in May, a rapid recession of flow in June, and a more gradual recession of flow through the summer, fall, and winter months. From the Parrish watershed, 73 percent of the annual discharge occurred in the April-June high flow period, about 9 percent in the July-September summer season, and about 2.5 percent in each of the other low flow months. Lowest discharges from the Centerville Watershed in each of the winter months average about 3.5 percent of annual; that in the three summer months about 13 percent, and 62 percent in the 3-month period of high flow. The maximum discharges during the high flow periods were 14.5 c. s. m. (cubic feet per second per square mile) and 10.1 c. s. m. for Parrish and Centerville, respectively. Under the impact of several high-intensity summer storms, the maximum instantaneous low flow discharges of either stream never exceeded 5 c. s. m. By contrast, summer storm discharges from a nearby untreated area, with plant-soil conditions comparable to those existing on Parrish before treatment, exceeded 2,000 c. s. m.

The effective control of summer storm floods in the Parrish watershed was accompanied by a decrease of 2.70 inches of annual runoff over the 22-year period, 83 percent of which occurred in the first 11 years. Most of the decrease in annual yield occurred during the high flow months of March, April, and May. June yields were slightly increased. Discharge reductions in all other low flow months were negligible.

Intermountain Forest and Range Expt. Sta., FS, USDA, Ogden, Utah.

Wilson, N. W. IN VIRGINIA FLOOD PREVENTION PROJECTS - NEW RESERVOIRS PROVIDE RECREATION. Va. Wildlife 21(8): 6-7. 1960.

The South River Watershed Project, though only half finished, has provided Waynesboro and surrounding Augusta County new recreation areas as well as flood protection.

Eleven of the 17 planned flood dams have been built. They control flood runoff from 22 percent of the 92,000-acre watershed. Their value was especially welcome when Hurricane Gracie dumped five inches of rain on the watershed in

September 1959. The dams held back millions of gallons of water, lowering flood waters more than a foot in Waynesboro.

The project also includes stream channel improvement, roadside erosion control, tree planting, and other upland conservation on farms. It is part of the Potomac River Flood Prevention Project.

One of South River's new reservoirs is located just above the CCC-built Sherando Lake in Big Levels Game Refuge. This 20,000-acre wildlife area has become the leading recreation area for local wildlife groups, scouts, and picnickers. The seven-acre trout-stocked lake formed by the flood-retarding dam has doubled swimming, fishing, and boating facilities in the refuge.

Two adjacent SCS-designed ponds give waterfowl added breeding and feeding areas and make a total of 11 acres of new water surface in Big Levels Refuge.

The Waynesboro Kiwanis Club purchased 250 acres of land including a reservoir site near Greenville. There, the Kiwanians are building a new camp that will give scores of underprivileged children a place to swim, boat, and fish.

Another one of the 11 dams, built on the grounds of a state convict farm, has given them a five-acre pond that serves several purposes. Built primarily for flood protection, it also gives the state farm water for crop irrigation, and fire protection. The prisoners will also have swimming and fishing privileges during limited recreation hours.

A small group of professional men purchased a 70-acre tract of land including a five-acre reservoir. The group is improving the woodland and planting feed and wildlife shrubs to attract wildlife. The area will be used as a summer campsite.

Other civic groups and local governments have similar interests in South River reservoir sites.

SCS, USDA, Richmond, Va.

Anderson, H. W., and Hobba, R. L. FORESTS AND FLOODS IN THE NORTHWESTERN UNITED STATES. In SH-M Sept. 8-13, 1959. p. 48, International Assoc. Sci. Hydrol., pp. 30-38. 1959.

Past floods from 75 watersheds in western Oregon and Washington were analyzed using graphical, multiple regression, and covariance analyses and the results summarized as follows: (1) In northwestern United States clear cutting of forests and forest fires have increased floods from watersheds for both rain-snowmelt floods and snowmelt floods; (2) where stocking of the forest has recovered with time in a watershed, the flood peak discharges have again decreased; (3) for watersheds with geology of marine sediments and for those with volcanic rocks the forest effects on floods were the same; (4) for great storms and small storms the effects of forest cutting on floods were the same; and (5) for rain-snow floods, forest effects on floods were greatest in the zone below the snowmelt line in a given storm and watershed. Evaluation of the meteorological, topographic, and geologic flood causes helped delineate the zones where forest management for flood prevention would be the most effective.

Pacific Southwest Forest and Range Expt. Sta., FS, USDA, Berkeley, Calif.

Hydrology

Kelly, L. L. STATE OF HYDROLOGIC, GEOLOGIC, AND ENGINEERING DATA. In Economics of Watershed Planning edited by G. S. Tolley and F. E. Riggs. pp. 96-110. 1960.

An adequate program for basic data involves more than recording the raw facts. They must be evaluated for validity, processed in an orderly manner, made available in meaningful and useful terms, and given objective interpretation.

As the times change and emphasis on various phases of water resource development shifts, there will be a need for new and different data. As understanding of the climate and the physical nature of our resources increases, we may find that we no longer need data of a particular type, but of a new type. The use of radar and other technological developments in meteorology, for example, may well revolutionize some of our ideas on methods for collection of precipitation and other climatic data.

The data discussed pertain to topography, geology, cadastral surveys of public lands, precipitation, snow, climate, streamflow, ground water, chemical and sanitary water quality, sedimentation, upstream watershed management, and soil moisture.

Without question, the one item that could improve the hydrologic and engineering data used in land and water resource planning and evaluation is to give the data more intensive analysis. This applies not only to such items as bridging the gap between small watersheds and major basins, but also to the whole field of hydrology, hydraulics, and resource engineering.

Additional comments on this topic were made by W. M. Snyder.

SWCRD, ARS, USDA, Beltsville, Md.

Reich, B. M. ANNOTATED BIBLIOGRAPHY AND COMMENTS ON THE ESTIMATION OF FLOOD PEAKS FROM SMALL WATERSHEDS. Civil Engin. Sect., Colo. State U. CER60-BMR52, 66 pp. 1960.

Some one hundred and eighty books and articles were reviewed for information of value in the estimation of peak runoff from small watersheds in and around the size range from 200 acres to three square miles. Their contents have been abstracted with emphasis on material pertinent to design methods and classified according to sixteen subject headings. The most useful estimation methods are briefly discussed, with special reference to procedures followed by the USDA Soil Conservation Service. Research programs are proposed which could bridge the gap between existing data and the application of more refined estimation techniques in countries where hydrometeorology is less advanced than it is in USA.

Civil Engin. Sect., Colo. State U., Fort Collins, Colo.

Schleusener, R. A., Smith, G. L., and Grant, L. O. FINAL REPORT: STUDY OF PEAK RATES OF RUNOFF IN EASTERN COLORADO AND ADJACENT AREAS. Civil Engin. Sect., Colo. State U. CER60RAS31, 95 pp. and plates. 1960.

The factors affecting peak rates of runoff in the semi-arid region of eastern Colorado and adjacent areas were studied. Within this region, annual maximum floods on watersheds less than 1000 square miles are usually the result of intense rainfall over a limited area. The investigation reveals that peak rates of runoff from ungaged watersheds can be estimated from parameters of watershed area, channel slope, and a soil infiltration index in the region east of the Rocky Mountain Foothills.

In the Rocky Mountain Foothills, estimates of peak rates of runoff from ungaged watersheds can be made using watershed contributing area, elevation, and location.

Design procedures for estimating peak rates of runoff in these regions are illustrated by examples. Results of the studies used to develop these design procedures are presented in summary form.

Civil Engin. Sect., Colo. State U., Fort Collins, Colo.

Bodhaine, G. L. FLOOD-FREQUENCY RELATIONSHIPS IN THE PACIFIC NORTHWEST. J. Hydraul. Div., ASCE 86 (HY 9): 1-10. 1960.

A method has been presented for determining the magnitude and frequency of floods to be expected at any site in the Pacific Northwest. Flood-frequency curves for individual stations are combined into several regional flood-frequency curves. The regions include stations for which slopes of individual flood-frequency curves are similar. The regional curves show flood magnitudes in terms of mean annual floods. To obtain the frequency curve for an ungaged site, it is only necessary to compute the mean annual flood for that site and convert the appropriate regional frequency curve to flow in cubic feet per second by multiplying the ordinates of that curve by the mean annual flood.

Magnitudes of mean annual floods have significant correlations with drainage area, mean annual runoff, area of lakes and ponds, and in some places with elevation. After all these factors are taken into account in multiple correlations, large residual standard errors still exist. These residuals tend to be of about equal magnitude in given geographical areas, suggesting that a factor such as geology of the area has a significant effect. So-called geographic factors based on residual errors are developed.

The formula for mean annual floods in western Washington is expressed in terms of drainage area, area of lakes and ponds, mean annual runoff, and the geographical factor. Similar equations have been developed for other areas in the Pacific Northwest. Drainage area and area of lakes and ponds are easily obtained from topographic maps. Mean-annual runoff is obtained from an isopleth map based on gaging-station records. Geographical factors are obtained from a map that has been divided into areas having residual errors of similar magnitude. The geographical factor is based on the median residual error for that area. Because all of these factors are readily available, the formula is easily applied.

The methods presented are subject to limitations. They cannot be applied to streams in which the regimen has been so altered by the works of man that satisfactory adjustments for such cannot be applied. Nor can such adjustments be applied to certain small streams in semiarid eastern Washington and Oregon in which practically the sole sources of runoff are local thunderstorms. Extensions of frequency curves beyond the 50-yr. recurrence interval are not justified, and extrapolation beyond that limit should be a computed risk taken only when no better estimate is available.

U. S. Geol. Survey, Tacoma, Wash.

Lull, H. W., and Rushmore, F. M. SNOW ACCUMULATION AND MELT UNDER CERTAIN FOREST CONDITIONS IN THE ADIRONDACKS. Northeastern Forest Expt. Sta. Paper 138, 16 pp. 1960.

The Adirondack region of New York is a land of many lakes and streams. It feeds water into Lake Champlain, Lake Ontario, the St. Lawrence River, and the Hudson River. Much of this streamflow comes from the melting of the spring snowpack in the Adirondacks.

About a fourth of the regions' annual precipitation of 35 to 50 inches accumulates in this spring snowpack. In some areas snowfall averages 140 inches a year. As a whole, the Plateau receives 80 to 100 inches of snowfall a year. Part of this comes in the fall, and melts; but the winter snowfall accumulates so that by March 15 snow depth may reach 30 inches. This is equivalent to about 10 inches of water.

The amount of snow that accumulates, and its rate of melt, depend in part on the type and condition of forest cover. The Adirondacks possess a great variety of forest types, ranging from pure conifer stands to hardwood stands occurring under virgin, cut-over, and burned conditions. This study compares snow accumulation and melt under certain of these types and conditions.

Snow measurements taken in the Adirondacks in the spring of 1959 showed that the snowpack in hardwood sapling and sawtimber stands contained two more inches of water than the snowpack in balsam fir and red spruce stands. In hardwood stands snow melted about twice as fast as in conifer stands, and snow disappeared about 9 days earlier. In mixed conifer and hardwood stands, snow accumulation and melt were intermediate. Average accumulation and melt values for the snow courses were correlated with canopy closure; and canopy closure, in turn, appeared to be correlated with the summation of inches of tree diameter per acre.

Northeastern Forest Expt. Sta., FS, USDA, Upper Darby, Pa.

Anderson, H. W. PROGRESS REPORT, 1957-58, CALIFORNIA COOPERATIVE SNOW MANAGEMENT RESEARCH. Pacific Southwest Forest and Range Expt. Sta., 56 pp. 1958.

Anderson, H. W., and Richards, L. G. PROGRESS REPORT, 1958-59, CALIFORNIA COOPERATIVE SNOW MANAGEMENT RESEARCH. Pacific Southwest Forest and Range Expt. Sta., pp. 57-94. 1959. THIRD PROGRESS REPORT, 1959-60, CALIFORNIA COOPERATIVE SNOW MANAGEMENT RESEARCH. Pacific Southwest Forest and Range Expt. Sta., pp. 95-140. 1960.

In July 1956, the Forest Service with the cooperation of the State of California started watershed management research in California's snow zone. The purpose of the research was to expand the present body of knowledge and develop and test ways of managing California's watersheds for improvement of water yield.

The 1957-58 Progress Report gives detailed objectives and methods of the eighteen separate studies then under way and progress for the first two years of the study. The second Progress Report, the 1958-59 report gives progress for that year. The third Progress Report gives results for the fourth year of the study in the sixteen studies still under way.

Snow has been measured at some ninety-one snow courses, representing many conditions of natural forest stands, forests logged in a variety of ways, and brushfields, both natural and cleared.

Soil moisture losses during summer have been measured at some three hundred points, representing a wide span of forest sites--different slopes, forest conditions, types of logging, methods of slash disposal, and natural and cleared brushfields.

Winter evaporation losses from snow have been measured in forest stands and openings, in large meadows, on exposed ridges, and on different slopes.

Streamflow and sediment measurements were continued in eleven experimental watersheds, one of which was partly logged last year and the logging effects on streamflow and sedimentation have been evaluated.

1960 was a year of moderately light snowpack, following the very light snowpack year of 1959 and the extremely heavy snowpack year of 1958. Charts, tables, and graphs.

Calif. Dept. Water Resources, and Pacific Southwest Forest and Range Expt. Sta., FS, USDA, Berkeley, Calif.

Anderson, H. W. PROSPECTS FOR AFFECTING THE QUANTITY AND TIMING OF WATER YIELD THROUGH SNOWPACK MANAGEMENT IN CALIFORNIA. West. Snow Conf. Proc. pp. 44-50, 1960.

No single way of managing land in the snow zone is going to give unqualified improvement in all aspects of water yield: more water, better timing of water yield, better quality of water, and reduced floods and sedimentation. If we apply management that will give us more water, we are likely to get more water sometimes when we don't want it. If we apply management that will give delayed water yield for summer irrigation, we may sometimes adversely delay the yield of water for winter power production. If we apply management to get the purest water, the greatest flood prevention, and the least sedimentation we may find it necessary to cover the land with water-hungry plants and we cannot expect the greatest water yield. In some places the conflicts will be critical; in other places trivial. Research results may allow us to resolve some of the conflicts and in any event point out the prospect for affecting the quality, quantity, and timing of water yield for various forest land and topographic sites.

In July 1956, The Forest Service, in cooperation with the State of California, started research aimed at improving California's water yield through management of land in the snowpack zone. Studies are of four general kinds: Inventory of present condition of water yield, land condition, and soil; basic studies of forest hydrology, meteorology, and snow; plot test of the effects of land management methods on snow accumulation and water losses; and preparation for pilot testing of land management of experimental watersheds for their effects on streamflow and sedimentation.

This article gives some of the results of research studies. The following is a list of the research problems that remain to be solved: (1) Can certain treatments of forest and brushlands, designed specifically to give greater water yield or delay yield longer, improve on these results? (2) When forests are logged, does the way that the slash is disposed of affect the timing and amount of water yield?

Pacific Southwest Forest and Range Expt. Sta., FS, USDA, Berkeley, Calif.

Weitzman, S., and Bay, R. R. SNOW BEHAVIOR IN FORESTS OF NORTHERN MINNESOTA AND ITS MANAGEMENT IMPLICATIONS. Lake States Forest Expt. Sta. Paper 69, 18 pp. 1959.

How forest cover affects water behavior is now being studied as part of an overall program of watershed management research in the Lake States area. First results of one phase of the study--snow accumulation and melt in the forests of northern Minnesota during the winter of 1956-57 are presented.

Although the forest plays a complex role in snow accumulation and melt, it basically does two things: (1) It acts as a barrier to snow accumulation; and (2) after snow has reached the ground, the same factors operate but their effect is reversed.

The pattern of snow accumulation and melt in this study behaved as follows: (1) All open fields lost snow earlier and faster than forested areas. (2) More snow accumulated in the hardwoods, but conifers retained it longer. (3) Stand density in conifer types influenced to some degree the amount of snow accumulation and the rate of melt. Lightly stocked stands caught more snow; dense stands retained it longer. (4) The pattern of cut in conifers also affected snow accumulation and melt. East-west strips caught most snow and retained it longer than any other treatment. (5) Stocking levels in hardwoods affect snow accumulation and melt in the same way as in softwoods, but differences are smaller. (6) Mixed stands of scattered conifers and hardwoods (white pine-hardwoods) are intermediate in their reaction between pure conifers and pure hardwoods. They catch more snow than pure conifer stands and retain it longer than pure hardwood stands--both very desirable features. And (7) this pattern of snow behavior conforms in general to both western areas with heavy snowfall and northeastern conditions, which have intermediate winter thaws.

Lakes States Forest Expt. Sta., FS, USDA, St. Paul, Minn.

Bay, R. R. CUTTING METHODS AFFECT SNOW ACCUMULATION AND MELT IN BLACK SPRUCE STANDS. Lake States Forest Expt. Sta. Note 523, 2 pp. 1958.

The black spruce bog type covers over a million acres of land in northern Minnesota. To learn something about the influence of different cutting methods in black spruce on the snowpack in this northern region, a study was initiated on the Big Falls Experiment Forest near Big Falls, Minn., during the winter of 1956-57.

Prior to cutting, the black spruce stand, located on peat soils, had a basal area of 110 to 140 square feet per acre in trees 4 inches and up. A majority of the cordwood volume was in trees 5 to 9 inches in diameter.

During the period of snow accumulation the effect of crown interception was quite noticeable. The open areas--open patches and clear-cut strips--received the most snow. Next in order was the shelterwood cutting with fairly large holes in the canopy. This was followed by the tree selection method, which had smaller openings. The dense, uncut stand received the least amount of snow on the ground.

During the period of melt, early March to mid-April, the role of the forest canopy in preventing melt became dominant. The local microclimate, which in the forest creates, affected the order of melt. The open patch, which was exposed to direct rays of the sun, lost its moisture most rapidly by sublimation and melt. This was followed by the shelterwood system, the check area, tree selection area, and the clear-cut strip. The actual amount of water in the snowpack is shown in Table 1.

TABLE 1.--Water content of snowpack under various cutting methods in black spruce

(Inches of water)

Date	Cutting method				
	Clear-cut strip	Single tree selection	Uncut unit	Shelterwood	Open patch
February 14	2.9	2.0	1.6	2.2	2.9
March 7	4.0	2.6	2.5	3.2	4.5
March 29	4.3	3.2	2.7	3.5	4.0
April 3	4.2	2.8	2.7	2.9	3.6
April 9	3.6	3.2	2.7	2.8	2.4
April 16[1]	3.2	2.9	2.5	1.8	1.5

[1] This was the last sampling date. Exceptionally high temperatures combined with heavy rains melted all snow by April 25.

Although these data were obtained during only one season, it appears that cutting narrow, east-west strips may result in a high total accumulation of snow and a reduced rate of melt in the spring. They accumulate snow very much like open areas, but during the melt period, the narrow strips are protected from direct rays of the sun by tall trees on the southern border. Large openings, which are exposed to direct sunlight, lose their snow most rapidly. Silvicultural systems that open up the stand to some intermediate degree are intermediate in their ability to catch snow and prolong snowmelt in the spring.

Lake States Forest Expt. Sta., FS, USDA, St. Paul, Minn.

Meginnis, H. G. INCREASING WATER YIELDS BY CUTTING FOREST VEGETATION. *In* Symposium Hannoversch-Munden. Sept. 8-13, 1959. P. 48, International Assoc. Sci. Hydrol., pp. 59-68. 1959.

Forest vegetation, much valued as watershed cover, levies heavy toll on water supplies as the price for keeping soils stable and in optimum condition for water intake and storage. And critical water shortages in the United States, as elsewhere, are prompting proposals to cut forests to obtain greater water yields.

The Coweeta Hydrologic Laboratory is a 5600-acre outdoor installation of the U. S. Forest Service where research has been under way since 1934 to develop principles of managing forest lands for water production and control. The Laboratory is in an 80-inch high rainfall belt of the Southern Appalachian Mountains; and its many small drainage catchments, from 25 to 200 acres each, occupy a rugged terrain of steep slopes and narrow ridges lying at elevations of 2200-5200 feet. Soils, chiefly weathered schists and gneisses, are relatively deep and porous and overlie rather tight bedrock. A dense, secondgrowth, deciduous hardwood forest supporting a rich flora of under-story plants is dominant with scattered pines on the drier ridges. There has been no logging or other disturbance since about 1923.

In earlier years Coweeta research pioneered in studies of timing and delivery of flows from undisturbed forest; and later in measuring streamflow response when forest land is badly used. The program is now largely geared to study of water yield processes, the factors affecting them, and how they may be modified by watershed management. Basic instrumentation at Coweeta has been precipitation-streamflow measurements prior to and following treatment of small unit watersheds, with treatment response gauged through changes in flow, using an undisturbed watershed as a permanent control. By calibrating test-unit performance against that of the control, reliable estimates of altered flow due to treatment can be made, and variations due to climate and other extraneous factors greatly minimized.

Two well-known, classical experiments at Coweeta afford conclusive evidence that cutting all forest vegetation can produce very substantial increases in water, delivered as usable, regulated flows. A third study, in which the shrub understory was cut, gave similar, though lesser, water-yield response.

Controlled experiments show large streamflow increments from clear cutting mountain hardwood forests on two small watersheds, first-year increases being 15 and 17 area inches, all as regulated base flows. The yearly increase levelled off at 11 inches after the 3rd year where all regrowth was cut back annually; but it declined progressively on the other unit where a young coppice forest grew back. Cutting a shrub-understory increased annual yield about 2 inches. Other experiments are measuring water yield response from stand density reduction, cutting cove hardwoods, and converting the native forest to pine and other cover types. Learning how to favorably influence water yields for specific situations will require much more basic research, particularly study of water use requirements of forest trees and of the related plant-soil-climatic factors governing the evapotranspiration process.

Southeastern Forest Expt. Sta., FS, USDA, Asheville, N. C.

Anderson, H. W., and Gleason, C. H. LOGGING EFFECTS ON SNOW, SOIL MOISTURE, AND WATER LOSSES. West. Snow Conf. Proc. pp. 57-65. 1959.

First year results show that all three methods of logging--strip-cutting, block-cutting, and commercial selection-cutting--increased maximum snow accumulation and decreased annual water losses.

At maximum snowpack there was 10 inches more water in 5- and 10-chain wide cut strips than in the adjacent uncut forest; the block cut and commercial diameter-limit cut areas had 5 to 7 inches more than the uncut forest.

Snowmelt rate in spring was greater in the commercial cutting area than in the uncut. Small amounts of snow remained longer in the uncut forest.

Summer soil moisture losses in soils 48 inches deep were decreased by logging: 3.2 inches by the strip cutting, 2.7 inches by the block cutting, and 0.9 inches by the commercial cutting.

Annual yield of water from precipitation of 46 to 47 inches was estimated to be increased by 8.6 inches in strip cut areas, by 6.3 inches in block cut areas, and by 3.4 inches under commercial cutting.

Pacific Southwest Forest and Range Expt. Sta., FS, USDA, Berkeley, Calif.

Anderson, H. W., and Gleason, C. H. EFFECTS OF LOGGING AND BRUSH REMOVAL ON SNOW WATER RUNOFF. In Commission of Surface Waters International Assoc. of Sci. Hydrol. 51: 478-489. 1960.

Water yield as affected by three types of logging in a red fir forest, by two kinds of slash disposal, and by brush removal is being studied in the snow zone of the Cascade-Sierra Nevada mountains of California. The effects on snow accumulation, snowmelt, summer soil moisture losses, interception, and estimated water yield in two years are reported.

In clear-cut strips twice as wide as the height of adjacent trees, 7 to 12 inches more water accumulated in the snowpack and 8 inches less water was used annually than in the adjoining uncut forest. In a block cutting of large trees, leaving only a few small trees, 5 inches more water was stored in the snowpack and 6 inches was saved annually. In a selectively logged area, where all trees less than 18 inches in diameter were left, 6 to 7 inches more water was stored in the snowpack, but only 3 inches of water was saved annually. Brush removal reduced summer water losses 3 to 6 inches, depending on the soil depth.

Snowmelt was affected by the method of disposal of the logging slash. The area in which the slash was piled and burned had 3½ inches more water in late spring than the area of untreated slash.

It is concluded that water yield from snow zone runoff can be influenced both in amount and time of delivery by the manner in which the areas are logged and by brush removal.

Pacific Southwest Forest and Range Expt. Sta., FS, USDA, Berkeley, Calif.

Berman, T. FRESH WATER FROM THE SEAS. Crops and Soils 13(3): 9-11. 1960.

The Office of Saline Water Conversion of the U. S. Department of the Interior has narrowed the field for converting sea water to fresh water from some twenty scientific and natural phenomena to five general categories. These include: (1) Distillation through artificial heat; (2) separation of salt water by membrane processes, of two or possibly three kinds; (3) freezing; (4) solar heat distillation; and (5) other chemical or electrical means of separation, including solvent extraction. Three of the more promising methods are discussed.

Distillation methods basically involve evaporation of some of the salty water and condensation of the resulting vapor. There are three general distillation processes: (1) Multiple-effect or long tube vertical--heated salt water is brought into contact with steam in a series of evaporators; (2) multi-stage flash--salt water is heated and then released into a series of low-pressure chambers, in each of which part of the liquid "flashes" into vapor; and (3) vapor-compression--salt water is boiled in tubes and the resulting steam is collected and compressed, then brought into contact with salt-water intake tubes where it heats new salt water while being condensed as fresh water.

Research workers have also reported encouraging progress in the method of desalination known as electrodialysis. This combines the features of electrolysis with ion-trapping properties of certain membranes. These membranes can be made to retain either positively- or negatively-charged particles. As a current is passed through a salt solution the salt ions are separated out and held by the membranes. The salt concentration in part of the liquid can be lowered, and eventually fresh water is attained.

The third method--freezing--is one of the newest under development and is attracting worldwide attention. This method uses the natural phenomena that at freezing temperatures, pure water, in the form of ice crystals, separates from the brine solution. These ice crystals are then washed free of salt and melted, leaving pure water.

Several types of freezing processes are under development. In one, salt water is pumped into a vacuum tank as a fine spray, where part of the brine evaporates rapidly. This evaporation causes the temperature to fall low enough to freeze about one-seventh of the remaining brine. The water vapor moves upward while ice crystals and salt water are removed from the bottom of the tank and separated. These ice crystals then pass into a second compartment. Meanwhile, the vapor is piped out of the first tank, compressed, and then piped into the second chamber where, being at a higher temperature, it provides energy for melting the ice crystals to pure water.

Another freezing method, known as the Cornell Process, uses the evaporation of a hydrocarbon refrigerant in direct contact with pre-cooled sea water. Ice slurry that is formed is washed free of salt and then melted by heat from the compressed refrigerant.

What will be the cost of fresh water produced by these various processes? The actual cost of large output plants today is about $2 to $3 per 1,000 gallons. Estimates on the newer methods range down as low as 40¢ per 1,000 gallons. However, best U. S. estimates consider 60¢ per 1,000 gallons to be more realistic. Present average cost of municipal water in this country is about 40¢ per 1,000 gallons.

Student, Rutgers--The State U., New Brunswick, N. J.

Geology

McDonald, H. R., and Wantland, D. GEOPHYSICAL PROCEDURES IN GROUND WATER STUDY. J. Irrig. and Drain. Div., ASCE 86(IR 3): 13-26. 1960.

Although geophysical methods of subsurface exploration were developed primarily for the petroleum industry, many of the procedures apply equally well in the search for ground water. The principles of the geophysical methods most useful in ground water exploration are described and illustrated. In addition, a new application of the electrical borehole logging is described which may be of great importance in locating leaky zones in irrigation canals.

The four major geophysical methods--the seismic, the electrical, the magnetic, and the gravity method are used. The one most suited in a given case should be used.

All geophysical methods have three common characteristics. They require: (1) Certain measurements to be made at the ground surface using special instruments; (2) that these measurements relate to, or reflect properties of, buried rocks and formations on structural conditions; and (3) that these relationships permit the geophysical data to be interpreted in terms of subsurface geology.

Bur. Reclam., U. S. Dept. Int., Denver, Colo.

Engineering Design

Porter, H. L., Jr., and Silberberger, L.F. STREAMBANK STABILIZATION. J. Soil and Water Conserv. 15: 214-216. 1960.

Vegetative field-planting efforts on streambanks in the Buffalo Creek Flood Prevention Project during the past decade are described.

Buffalo Creek Watershed covers an area 437 square miles in northwestern New York State, with 21 square miles lying within the city limits of Buffalo. The last 6 miles of the creek is known as Buffalo River and is an important part of the harbor at Buffalo.

The greater part of the watershed lies in the Allegheny Plateau. A small portion is in the Erie-Ontario plain. The slopes in the watershed are very long and the hills rise from 600 to 1,000 feet above the valley floor. Precipitation averages about 38 inches annually. Winter floods with large ice floes are common and add to streambank stabilization problems.

The problems of establishing vegetation are tied closely to the construction and re-alignment work being done. The early work consisted of bulldozing local deposits of sand, gravel, and rock against the eroding banks for toe-protection. The curves were smoothed and the banks sloped for shrub planting. Approximately 16 miles of bank were treated in this manner, but the bank material was generally unsuitable for plant growth.

Since 1950, a more "permanent" stabilization job has been done. The toe and lower banks have been riprapped with quarried rock, and the upper bank planted.

With both systems, vegetation was a planned part of the stabilization program, and included in the engineering design. Channel control is based on both structural and vegetative methods.

In addition to protecting the streambank, a cover must be established on the adjoining areas disturbed by construction operations. This is particularly important when such areas are subject to bank overflow.

SCS, USDA, Upper Darby, Pa.

Cedergren, H. R. SEEPAGE REQUIREMENTS OF FILTERS AND PERVIOUS BASES. J. Soil Mechanics and Found. Div., ASCE 86(SM 5): 15-33. 1960.

The solutions presented illustrate application of the flow-net to the analysis of permeability requirements of filters and pervious bases for the removal of steady seepage. A complete analysis should also take into consideration the possibility of temporary flooding and rise in saturation caused by capillarity.

The numerical examples and flow-net solutions point up the relatively major influence of boundary conditions and seepage gradients upon the minimum permeability that will assure the rapid removal of steady seepage.

Application of these methods depends upon knowledge of the effective or average permeability of the saturated media from which water is being drained. This determination is the most difficult part of the analysis, and should have the benefit of an experienced evaluation of all available information, including permeability data, ground water observations, and records of performance of projects in the area when such records are available. Every effort must be made to detect and evaluate the presence of porous seams and joints that are easily overlooked but that contribute substantially to the flow of water.

Charts are presented that provide flow-net solutions for two common types of filter design. While the purpose of the charts is to demonstrate a design method, rather than to provide general solutions, they should have some practical value for filter design in conditions comparable to those assumed.

The analysis presented lead to the conclusion that relatively high permeability is needed in filter materials when boundary conditions restrict discharge gradients to small values. In such cases, coarser gradings of filters may sometimes be permitted without danger of infiltration and clogging. In cases where a single layer cannot safely remove the incoming water without danger of infiltration or clogging, other designs should be used, such as multiple-layer or graded filters. In such cases, the layer in contact with the soil should be designed to prevent clogging or infiltration, and another layer should be designed to provide the required water-removing capacity.

The solutions point to the desirability of a general appraisal of some commonly accepted specifications for filter materials. Classes of materials should be provided that will not only assure protection against infiltration when this protection is needed, but will have sufficient water-removing capacity to meet the needs of individual installations. Because any analysis of this kind can only approximate true conditions, reasonable margins of safety should be provided. Flow-net solutions can furnish a yardstick that is consistent with available knowledge of seepage gradients and soil conditions.

Materials and Research Engin., Calif. Div. Highways, Sacramento, Calif.

Smerdon, E. T., and Beasley, R. P. CRITICAL TRACTIVE FORCES IN COHESIVE SOILS: STUDIES SUPPORT THEORY IN EVALUATING STABILITY IN OPEN CHANNEL DESIGN. Agr. Engin. 42: 26-29. 1961.

Stability is of great importance in any field of engineering concerned with the design of open channel water conveyance systems. To date the following criteria have governed the design of open channels; the concept of limiting velocities, the regime theory, and the tractive force theory. The first two of these are strictly empirical in nature, while the latter is primarily theoretical in that it offers a way to evaluate shear at the interface of flowing water and the channel bed material. However, for open channels constructed in cohesive soils, the relationship between boundary shear and soil movement has not been adequately determined.

In order to determine some basic relationships between critical tractive force and the physical properties of cohesive soils, a series of tests was outlined. Eleven Missouri soils were selected for testing. These soils were chosen in order to give considerable range in soil cohesion and the ease with which the aggregates disperse in water. The tests included physical tests on the soils to determine their physical properties and hydraulic tests to determine the critical tractive force.

Physical tests included mechanical analysis, plastic limit, liquid limit, voids ratio, aggregate analysis, and specific gravity.

The author concludes that: (1) The problem of the stability of open channels in cohesive soils can logically be approached on the basis of the tractive force theory. The effect of cohesion can be measured by physical tests of the soils and related to the critical tractive force. (2) The critical tractive force was determined by two independent methods. The results appear not to be the same, but a definite correlation exists between the values obtained by the two methods. (3) For the soils tested, the critical tractive force is well correlated with the plasticity index, the dispersion ratio, the mean particle size, and the percent clay. And (4) the values of critical tractive force reported are for soils with voids ratios ranging from 1.23 to 1.84. Voids ratios of this magnitude correspond to a loosely compacted soil.

Agr. and Mech. Col. Tex., College Station, Tex.

Laflen, J. M., and Beasley, R. P. EFFECTS OF COMPACTION ON CRITICAL TRACTIVE FORCES IN COHESIVE SOILS. Mo. Agr. Expt. Sta. Res. B. 749, 8 pp. 1960.

Design criteria for open channels have been almost entirely empirical in nature in the past. The tractive force theory, however, presents a theoretical means of evaluating shear at the interface between flowing water and the channel bed material. This shear is the force that causes erosion of the bed material in an open channel. The effect of soil compaction on the tractive force required to cause erosion was studied.

Five soils from the state of Missouri were tested in a hydraulic flume located below the 16-acre reservoir at the McCredie Experiment Station. The hydraulic flume was 60 feet long, 2.51 feet wide, and 1.5 feet deep.

The authors concluded that: the linear relationship between the voids ratio and the critical tractive force for each soil tested indicates that the critical tractive force varies directly with the degree of compaction.

Results of this study also indicate that the critical tractive force varies with the soil.

Agr. Expt. Sta., U. Mo., Col. Agr., Columbia, Mo.

Taylor, G. S. DRAINABLE POROSITY EVALUATION FROM OUTFLOW MEASUREMENTS AND ITS USE IN DRAWDOWN EQUATIONS. Soil Sci. 90: 338-343. 1960.

A procedure is described for determining drainable porosity at equilibrium conditions from fluid outflow and water table measurements. This procedure is more accurate but more time-consuming than one that evaluates drainable porosity from fluid-content determinations. An equivalent drainable porosity is defined for nonequilibrium conditions that can also be evaluated from fluid outflow and water-table measurements. The use of drainable porosity in drawdown equations is discussed, and its evaluation from field drainage data is described. Some experimental evaluations of drainable porosity and equivalent porosity are presented.

Ohio Agr. Expt. Sta., Wooster, Ohio.

Robinson, A. R. VORTEX TUBE SAND TRAP. J. Irrig. and Drain. Div., ASCE 86(IR 4): 1-33. 1960.

Tests were made on a type of bed load ejector termed the vortex tube sand trap. These tests have shown that the following design criteria are necessary for the successful operation of the device: (1) The velocity and depth of flow across the section containing the tube should be such that the Froude number approximates 0.8. (2) The percentage of flow removed by the tube is a function of the depth and velocity of flow in the channel as well as width of opening, area, angle, and length of tube. The flow removed usually ranges from 5% to 15% of the total. (3) The width of opening should usually be in the range of 0.5 ft. to 1.0 ft. (4) The ratio of length of tube to width of opening (L/D) should not exceed 20 with the maximum length of tube being approximately 15 ft. (5) The tube angle should be 45°. (6) Straight tubes operate as well as tapered ones. (7) The elevation of the upstream and downstream lips of the tube can be the same rather than having the downstream one lower. (8) The shape of the tube does not seem to be particularly important as long as this shape is such that material entering the tube is not allowed to escape back into the channel. A pipe with a portion of the circumference removed seems to operate as well as other prefabricated shapes. (9) The required area of the tube can be approximated by the relationship $A_T = 0.06 \quad D\ L\ \sin$. Where A_T = cross section area, D = width of opening, and L = length of tube. And (10) with the foregoing design specifications, the tube can be expected to remove approximately 80% of the sediment with sizes greater than 0.50 mm. The trapping efficiency of smaller sizes will be considerably lower.

SWCRD, ARS, USDA, Fort Collins, Colo.

Furness, L. W. KANSAS STREAMFLOW CHARACTERISTICS: PART I. FLOW DURATION. Kansas Water Resources Board Tech. Rpt. 1, 213 pp. 1959.

Flow duration curves have been developed from daily records of streamflow at 122 sites in Kansas and adjoining areas. These curves show the percentage of time various rates of discharge have been equalled or exceeded. The flow-duration data observed at individual sites have, by correlation with selected long-term records, been extended in time to reflect the 36-year period 1921-56 and expanded in areal coverage to reflect regional rather than local experience. The period 1921-1956 is one in which both wet and dry periods are well represented and therefore is a reasonable base for prediction purposes.

The mean flows or yields of streams are readily determined from their flow duration curves. Using duration data developed in this report, the yields of Kansas streams in general are delineated on a map by use of values of mean flow for the drainage areas above the farthest upstream gaging stations on each stream and its tributaries and the successive intervening drainage areas for the gaging stations lying downstream therefrom. This map reveals that mean flow decreases quite uniformly across the State from a maximum of 0.8 cubic feet per second per square mile in southeastern Kansas to a hundredth of that amount in some portions of western Kansas.

Methods for synthesis of flow-duration curves for ungaged areas are developed. Curves and maps are presented from which may be derived five points and an average slope factor of the synthetic curve.

Charts, tables, and maps.

Kansas Water Resources Board, Topeka, Kans.

Furness, L. W. KANSAS STREAMFLOW CHARACTERISTICS: Part II. LOW-FLOW FREQUENCY. Kansas Water Resources Board Tech. Rpt. 2, 179 pp. 1960.

Low-flow frequency curves have been developed from records of daily streamflow at 115 gaging stations in Kansas and adjoining areas. These curves show how frequently on the average a stream may fail to provide various average rates of flow under natural conditions and in some instances under regulated conditions. Eight separate frequency curves for each station evaluate the minimum average flow expected in periods of 1, 7, 15, 30, 60, 120, 183 days, and 12 months, respectively. By correlation with selected long-term records, the low-flow data observed at individual sites have been extended in time to reflect the 37-year period 1920-56, and have been expanded areally to reflect regional rather than local experience.

Low flows in Kansas streams tend to decrease progressively to the west with such exceptions as lower amounts in the Marais des Cygnes basin and higher amounts in parts of south central Kansas. Maps compare the variations of minimum flow in Kansas for equal sized basins.

Procedures are outlined for estimating low-flow frequency curves on streams in Kansas of more than 100 square miles drainage area where no gaging stations have been operated. At low flow, the estimates are based on discharge measurements made at base flow. At higher flows where base-flow measurements are seldom obtainable, maps of the geographic variations provide valuable information.

The low-flow frequency curves, which are based on unregulated flow, can be used in the study of future water developments. The recent accelerated expansion of water uses makes it essential that natural stream behavior be defined while natural conditions still prevail.

Charts, tables, maps, and graphs.

Kansas Water Resource Board, Topeka, Kans.

Peterson, D. F., and Mohanty, P. K. FLUME STUDIES OF FLOW IN STEEP, ROUGH CHANNELS. J. Hydraul. Div., ASCE 86 (HY 9): 55-76. 1960.

Based on observations of both natural streams and flume experiments, three classifications of flow in steep, rough, open channels are proposed: tranquil, tumbling, and rapid. The tranquil and rapid regimes are dominated by subcritical and supercritical flow, respectively. In the tumbling regime the roughness elements induce supercritical flow over their crests followed by individual hydraulic jumps to the tranquil state. The characteristics of flow in each of the proposed regimes are described, and criteria for delineating the regimes are proposed.

Utah State U., Logan, Utah.

Snow Surveys

Hedrick, C. SNOW SURVEY FORECASTS MAKE THE DIFFERENCE BETWEEN SUCCESS AND FAILURE. Soil Conserv. 26: 115-116. 1960.

In April each year the Co-operative Snow Survey, the annual winter-to-spring checkup by the Soil Conservation Service and participating agencies on mountain snow and water content, reports the yearly forecast of the available water supply for irrigation. This report is used by the farmers to plan their yearly cropping system.

The April 1959 snow survey report showed a water yield of .34 acre foot per share. John Pastoor of Twin Falls, Idaho, has 687 shares of water. By using water with top efficiency he ordinarily has enough for his 200 acres under irrigation.

In 1959 Pastoor, using the estimate of the irrigation supply, figured he would have 233 acre-feet of water for the season.

He actually prepared and seeded 103 acres, with 78 acres in wheat and 25 acres in peas. The rest of his land he put in hay and grass, which have relatively low water requirements.

By making sure that he would have the needed water for the wheat and peas, Pastoor had been able to make top use of fertilizer and the water actually available. The wheat yielded 80 to 90 bushels per acre and the peas yielded 30 sacks per acre.

Toward the end of the season, Pastoor found he could put enough water on a planting of Siberian wheatgrass to get a seed crop. It grossed just over $200 an acre.

"They've been working on this run-off forecasting a long time now," Pastoor said. "The estimates we farmers get on the water outlook are worth a lot of money to us if we are willing to use them. I don't see how any farmer, given this information, can fail to take advantage of it. To me, it is just the difference between a successful farming year and a complete failure. It's not a hard choice for me to make."

SCS, USDA, Twin Falls, Idaho.

Ground Water Recharge

Muckel, D. C. REPLENISHMENT OF GROUND WATER SUPPLIES BY ARTIFICIAL MEANS. U.S. Dept. Agr. Tech. B. 1195, 51 pp. 1959.

Replenishment of ground water supplies by artificial means has been practiced in the United States since 1900. Early efforts were limited to those areas where the surface soil and underground conditions were well suited to artificial replenishment. Since the drought years of the 1930's, the need for artificial replenishment has extended to areas where the surface and subsurface soils are not ideally suited to water spreading because of low infiltration and percolation rates.

Artificial recharge is accomplished by two general methods: (1) Spreading water over the surface of the land to permit the water to infiltrate into the soil and travel downward until it reaches the water table; and (2) diverting water into wells, shafts, or pits from which it infiltrates to the water table.

Surface spreading may be accomplished by use of basins, furrows or ditches, or by flooding. The basin method of surface spreading is the most commonly used. The surface storage capacity of basins is helpful for regulatory purposes where the supply of water fluctuates. If the water supply contains silt, basins can be arranged so that the uppermost basin of a series can be utilized as a settling pond. For a given gross area assigned to spreading, a greater area is wetted by the use of basins than by any other method of surface spreading.

Pits, shafts, or wells have been tried in many places with varying results. Best results were obtained if chlorinated water of very low silt content is used. Wells or shafts are used only under special conditions where surface spreading is not feasible or where adequate area is not available for surface spreading. Where surface soils or substrata of very low permeability exist between the surface and the water table, wells or shafts penetrating the strata are the only means of recharge.

The problem of decreasing infiltration rate presents itself in all types of surface spreading where the water is applied for long uninterrupted periods. The products of microbial activity seal the soil during wetting, but tend to improve the aggregation of the soil upon drying. This aggregation may in turn cause percolation rates higher than the initial rate. Spreading of waters containing large quantities of silt will cause a rapid decrease in infiltration rate and may overshadow any effect of micro-organism activity. Initial infiltration rates can be recovered by interrupting spreading operations and permitting the soil to dry to or near the wilting point. This method will work unless the decrease in infiltration rate has been caused by silt, which must be removed. Best infiltration rates are obtained on a given soil if vegetation is allowed to grow and the soil is not disturbed in any way. Infiltration rates can usually be improved by adding organic matter to the surface soil and permitting it to decompose under moist conditions followed by a drying period.

The use of infiltrometers or small ponds to predict the infiltration rate obtained under large areas is of value only when there is no substratum that retards the downward movement of water. Soil surveys and well logs should be examined carefully when selecting an area for spreading. Material of low permeability should be mapped, and a determination made on whether or not the low permeability material is continuous or in lenses. Better results are obtained by careful selection of a suitable spreading site than by attempting to improve a less desirable site.

Under most conditions water spreading cannot be considered a means of flood control. It is used, however, in combination with flood control structures that impound or otherwise control the water and divert it to spreading systems.

ARS, USDA, Inform. Div., Washington 25, D.C.

Irrigation

Munson, W. C. METHOD FOR ESTIMATING CONSUMPTIVE USE OF WATER FOR AGRICULTURE. J. Irrig. and Drain. Div., ASCE 86(IR 4): 45-57. 1960.

Estimates of monthly and annual consumptive use of water for agriculture are essential for the planning of potential irrigation projects. Formulas have been developed which consider complex functions of the many variables involved and result in mathematically exact computations of evapotranspiration which may vary considerably among the different formulas, depending upon the researchers' evaluation of the various factors involved.

This paper presents data on measured rates of consumptive use of water as well as estimated consumptive use determined by various formulas and describes a procedure for determining monthly and annual water requirements, on a project basis, from climatological data for areas where measurements of consumptive use are not available. The simple method for estimating consumptive use of water for agriculture is called the Precipitation-Evaporation or P. E. Index method.

Results obtained by the P. E. Index method were compared with those obtained by many other methods over a wide geographical range and a great divergence in cropping procedures as well as different crops. It is believed that the validity of the P. E. Index method has been shown to be comparable to that of any other method and has the advantage of its extreme simplicity.

Although the P. E. Index method was not intended for use with individual crops or for very short periods of time, the results shown in this paper indicate that it may have possible use as a rapid check of the more involved methods used for these purposes.

Bur. Reclam., U. S. Dept. Int., Washington, D. C.

Hansen, V. E. NEW CONCEPTS IN IRRIGATION EFFICIENCY. Trans. ASAE 3(1): 55-57, 61, 64. 1960.

Adequate control and management of irrigation water requires that methods be available to evaluate the irrigation practice from the time the water leaves the point of diversion until it is utilized by the plant.

The concept of water conveyance efficiency adequately evaluates the conveyance phase and the concept of water application efficiency adequately describes the tendency for excess application. Both concepts have been, and will continue to be, extremely useful.

Three new irrigation efficiency concepts have been proposed to aid in controlling the irrigation practice. Water storage efficiency is useful whenever insufficient water is applied to the root zone during the irrigation; water distribution efficiency evaluates the uniformity with which the water is distributed throughout the root zone; consumptive use efficiency measures the ability of the roots to utilize the moisture placed in the root zone during irrigation.

All five aspects of irrigation efficiency are needed to adequately describe the irrigation practice and to focus attention upon the methods which must be improved to obtain maximum benefit from the irrigation water.

Utah State U., Logan, Utah.

Musick, J. T. IRRIGATING GRAIN SORGHUM FOR EFFICIENT WATER USE. Soil Conserv. 26: 117-119. 1960.

Experiments were started in 1954 and continued through 1959 at the Garden City Branch Experiment Station in western Kansas to study water management of irrigated grain sorghum. They were conducted on Ulysses cl. The soil has a deep, moderately permeable profile underlain with loess. Available water holding capacity is about 2.0 inches per foot of depth. The average annual precipitation is 17.98 inches but varies considerably from year to year.

The greatest causes of low grain yields are moisture stress and low soil fertility, particularly nitrogen. Moisture stress, which decreased yields, resulted in inefficient use of water for grain production.

The irrigation water requirement depends on the amount and distribution of rainfall and how fast the crop is growing. The daily rate of water use has a characteristic pattern throughout the growing season. Water use increased from less than 0.10 inch per day for young plants to slightly over 0.30 inch per day during the peak use period, from the time plants start to head until the grain has reached the milk stage.

Irrigation increased grain yields in all years the experiments were carried on, but the increases varied considerably. The average yield for the 5 years was 4,100 lbs. per acre from preplanting irrigation only and 6,500 lbs. per acre for the maximum yield treatment. Dryland fallow yields during the same period average 1,800 lbs. per acre.

Each successive irrigation increased yields less than the previous irrigation. Preplanting irrigation, that wet the soil to a depth of 6 feet, increased yields an average of 2,300 lbs. per acre over dryland fallow. An additional irrigation at 10- to 14-inch plant height increased yields 1,610 lbs. more per acre. A third irrigation at boot to early heading stage increased yields still another 600 lbs. per acre. The last irrigation at milk to soft dough increased yields only 180 lbs. per acre. A well-timed irrigation sometimes increased grain yields up to 3,000 lbs. per acre and produced over 400 lbs. of grain per acre-inch of additional water stored in the soil by irrigation.

During most years, near-maximum yields occurred for a total water use of 20 to 22 inches. Very little increase in yield occurred past 22 inches of water use. As the seasonal water use decreased below 20 inches, grain yields decreased at a faster rate. Research in the Plains has indicated that from 8 to 10 inches of water must be available before plants will produce grain.

Two irrigations after planting usually resulted in near maximum yields.

Other management and cultural practices are important to produce high yields. A fertility deficiency may greatly decrease yields and water use efficiency. Planting in narrow rows (7 to 14 inches) combined with optimum irrigation has increased grain yields. Adapted hybrids should be used. Weeds are a serious competitor for water and should be controlled. Water losses from ditches, field runoff, and deep percolation below the crop root zone should be minimized. Efficient use of water cannot be obtained from inefficient management or a poor water distribution system.

ARS, USDA, Garden City, Kan.

Frost, K. R., and Schwalen, H. C. EVAPOTRANSPIRATION DURING SPRINKLER IRRIGATION. Trans. ASAE 3(1): 18-20, 24. 1960.

It is necessary to determine quantatively the increase of moisture in the soil caused by the sprinkling operation and the evapotranspiration losses in a complete study.

To determine the combined loss from evaporation and transpiration of the water reaching the plants during sprinkling, it is necessary to consider the moisture in the soil before and after sprinkling and the amount of water added to the drop area by sprinkling. The experiments were conducted with small tanks 20 to 24 in. in diameter and 10 in. deep.

The authors concluded: (1) Except in cases of bare ground and/or high winds, evapotranspiration losses during sprinkling may be neglected when calculating application losses, since they are about equal to normal evapotranspiration losses when not sprinkling. (2) Dry-leaf evapotranspiration equals or exceeds wet-leaf evapotranspiration under similar atmospheric conditions. (3) Evapotranspiration losses whether sprinkling or not reach a peak near midday, increasing with the vapor-pressure deficit and the wind velocity. (4) Due to a net reduction in evapotranspiration at low wind velocities during the sprinkling period, sprinkling on a complete cover of growing crops should result in application efficiencies equal to flood or furrow irrigation. (5) Losses during sprinkling are about the same for all crops tested, but tests were only made on low-growing crops. (6) Evaporation from bare soil during sprinkling was very close to that found for evapotranspiration of crops on equivalent areas. And (7) these conclusions suggest that to conserve water, sprinkling on bare soil should be done at night. Sprinkling on a growing crop during the day should equal the application efficiency of night sprinkling.

U. Ariz., Tucson, Ariz.

Merriam, J. L. FIELD METHOD OF APPROXIMATING SOIL MOISTURE FOR IRRIGATION. Trans. ASAE 3(1): 31-32. 1960.

This chart, or a similar one prepared for a specific soil group, using the direct approach of describing soil moisture in terms of deficiencies, will help technicians and farmers to get the habit of making soil-moisture deficiency observations. This is a basic step in obtaining efficient irrigation.

SOIL MOISTURE AND APPEARANCE RELATIONSHIP CHART

Moisture deficiency, in./ft.	SOIL TEXTURE CLASSIFICATION				Moisture deficiency, in./ft.
	Coarse (loamy sand)	Light (sandy loam)	Medium (loam)	Fine (clay loam)	
	(field capacity)	(field capacity)	(field capacity)	(field capacity)	
0.0	Leaves wet outline on hand when squeezed.	Appears very dark, leaves wet outline on hand; makes a short ribbon.	Appears very dark; leaves a wet outline on hand; will ribbon out about one inch.	Appears very dark; leaves slight moisture on hand when squeezed; will ribbon out about two inches.	0.0
0.2					0.2
	Appeara moist; makes a weak ball.	Quite dark color; makes a hard ball.	Dark color; forms a plastic ball; slicks when rubbed.		
0.4				Dark color; will alick and ribbon easily.	0.4
	Appears slightly moist. Sticks together slightly.				
0.6	Very dry, loose; flows through fingers. (wilting point)	Fairly dark color, makes a good ball.	Quite dark, forms a hard ball.	Quite dark, will make a thick ribbon; may slick when rubbed.	0.6
0.8		Slightly dark color, makes a weak ball.	Fairly dark, forms a good ball.	Fairly dark, makes a good ball.	0.8
1.0		Lightly colored by moisture will not ball.			1.0
1.2		Very slight color due to moisture. (wilting point)	Slightly dark, forms a weak ball.	Will ball, small clods will flatten out rather than crumble.	
1.4					1.4
1.6			Lightly colored; small clods crumble fairly easily.	Slightly dark, clods crumble.	1.6
1.8			Slight color due to moisture, small clods are hard. (wilting point)		1.8
2.0				Some darkness due to unavailable moisture, clods are hard, cracked. (wilting point)	2.0

THIS chart indicates approximate relationahip between field capacity and wilting point. For more accurate information, the soil must be checked by drying aamples of it. The descriptions at the top of each textural column correspond to the condition of zero soil-moisture deficiency, i.e., field capacity. Those descriptions at the bottom of a column describe a soil having the maximum deficiency, i.e., at wilting point. The soil-moisture deficiency at this condition is numerically equal to the available moiature range of the soil. Intermediate soil-moisture deficiency descriptions occur opposite corresponding numerical values of inches of water per foot of depth at which the soil is deficient. This chart describes a specific group of soils and though it has been found to have general application, it may not apply to many other groups. Where this is the case, new descriptions will need to be prepared corresponding to particular soil-moisture deficiency, feel, and appearance relationships.

Calif. State Polytech. Col., San Luis Obispo, Calif.

Bilbro, J. D., Jr., Clyma, W., Newman, J. S., Jensen, M. E., and Sletten, W. H. A PRELIMINARY EVALUATION OF THE LEAF-COLOR-CHANGE METHOD AS AN INDICATOR OF THE OPTIMUM TIME TO IRRIGATE COTTON ON THE HARDLANDS OF THE HIGH PLAINS. Tex. Agr. Expt. Sta. Progress Rpt. 2159, 7 pp. 1960.

Plots irrigated on the basis of leaf-color-change produced the highest yields and highest gross values of lint cotton. However, these plots received 5.5 acre-inches more irrigation water than any of the other treatment plots. The per-pound value of the fiber from all the irrigated plots was somewhat lower than that from the dryland plots as the lint from the irrigated plots was light spotted in color. Staple lengths were similar for all soil-moisture levels. Lint percentages decreased as total irrigation water increased. Upper-half-mean fiber length was slightly longer in the plots from the soil-moisture-level treatment that received the most irrigation water; micronaire (fineness) values were lowest in these plots. Fiber strength values were not significantly different among the soil moisture levels.

The three varieties did not differ significantly in yield, gross value of lint, upper-half-mean fiber length, or staple length. Lankart 57 had the highest average lint percentages and micronaire values, but the lowest fiber strengths; Paymaster 101 and Blightmaster were similar in fiber strength. Lankart 57 and Paymaster 101 had significantly higher micronaire values than Blightmaster.

Moisture extraction patterns followed the expected trends; that is, moisture was first utilized from the top 9-inch zone followed by that from progressively lower depths. In some plots moisture was utilized from as deep as 42 inches.

On the basis of this preliminary study, the leaf-color-change method for determining when cotton should be irrigated generally cannot be recommended even though this method insured an adequate supply of soil moisture. Further experimentation on this same soil and on soils of different types and with different levels of fertility (particularly nitrogen) will be necessary to evaluate critically this method.

CRD, ARS, USDA, and Tex. Agr. Expt. Sta., College Station, Tex.

Wilcox, L. V. DETERMINING THE QUALITY OF IRRIGATION WATER. U.S. Dept. Agr., Agr. Inform. B. 197, 6 pp. 1958.

The quality of an irrigation water depends upon the kind and amount of salts that are dissolved in it. A chemical analysis will show what salts are present and in what amount. From such an analysis, it is possible to decide on the suitability of the water for irrigation use.

The purposes of this publication are: (1) To describe the characteristics of an irrigation water that determine its quality; (2) to indicate the type of water analysis that is required; and (3) to show how to judge quality from the water analysis.

ARS, USDA, Inform. Div., Washington 25, D.C.

Hausenbuiller, R. L., Haque, M. A., and Wahhab, A. SOME EFFECTS OF IRRIGATION WATERS OF DIFFERING QUALITY ON SOIL PROPERTIES. Soil Sci. 90: 357-364. 1960.

Results are presented for a field study in which analyses of soils from 11 sites are compared with the compositions of waters used to irrigate them. Highly significant correlations were obtained between exchangeable Na in the soil and "residual Na_2CO_3" content, soluble Na percentage, and the Na-adsorption ratios of the waters. No relationship was found between conductivities of the waters and those of the saturation-paste extracts.

A highly important contributing factor to behavior of the waters in the soil is their $HCO_3 + CO_3$ content. These ions are capable of reducing the "effective salinity" of the water while increasing the soluble-Na percentage through precipitation of soluble Ca and Mg.

A controlled irrigation study in soil columns was used to determine the effect of varying the Na:Ca ratio and content of HCO_3 in synthetic irrigation water on soil properties. Continuous leaching accompanied treatment in the columns.

Removal of exchangeable Ca by percolating waters containing HCO_3 occurred even when the soluble-Na percentage in the added water was only 50. Reduction in the added Ca through precipitation apparently raised the "effective" Na percentage in the percolating waters to a critical level.

It is concluded that the length of time during which percolating waters remain in contact with the soil will determine partially the extent to which the HCO_3 ions added enter into precipitation reactions with Ca. This relates to the slowness with which complete precipitation of carbonates occurs and, where plants are growing, the extent of removal of percolating water by active roots with a resultant increase in ion concentrations in the solution phase.

Penjab Agr. Col., Lyallpur, West Pakistan.

Berg, P.H. METHODS OF APPLYING IRRIGATION WATER. J. Irrig. and Drain. Div., ASCE 86(IR 3): 71-82. 1960.

A complete plan for irrigating a farm should be prepared before installing a system. The farm should, as nearly as possible, be divided into permanent fields based on soils and topography, and a method selected for irrigating each field. This will provide the basis for designing the water supply and distribution systems. It will also help determine those fields which may require some modification to the topography by land grading. A table (see page 21) is provided as a simplified aid in selecting the method of irrigation for various fields.

The final selection of the water supply and distribution system, methods of irrigating farm fields, and the types of crops to be grown will be dependent not only on the initial cost of development but also on the annual cost in materials and labor. Under present day conditions, the annual cost is of major importance.

Kansas River Proj., Bur. of Reclam., U.S. Dept. Int. McCook, Nebr.

Finkel, H. J., and Nir, D. CRITERIA FOR THE CHOICE OF IRRIGATION METHOD. Trans. ASAE 3(1): 92-96. 1960.

The choice of irrigation method is frequently determined by certain limiting conditions which preclude one or another of the possibilities and leave no alternative. In other cases, where both surface and pressure-pipe irrigation are theoretically possible, the choice must be based upon the weighing of several factors of which the economic is often, but not always, the governing factor. This paper reviews in a systematic fashion the necessary and sufficient conditions which apply to each type of irrigation so that the final selection can be made on the basis of sound criteria. In those cases where the choice is difficult, reference was made to experimental data. The factors to be considered are grouped under the following headings: water supply, topography, climate, soils, crops, economics, and the human element.

Technion, Israel Inst. Tech. (Haifa) Technion, Israel.

Phelan, J. T. BENCH LEVELING FOR SURFACE IRRIGATION AND EROSION CONTROL. Trans. ASAE 3(1): 14-17. 1960.

Most of the experience and research on surface irrigation has been obtained at locations where erosion and drainage problems created by natural rainfall have been unimportant. Irrigation in non-arid areas is on the increase and it is imperative that attention be given to the problem of erosion control on these lands.

The usual means of controlling erosion in humid regions is often diametrically opposed to the customary methods of surface irrigation as practiced in the arid areas. To prevent erosion on cultivated fields, contour methods are recommended. Modifications in irrigation practices are essential for their successful use in areas subject to intensive rainfall.

Reduction of slope affords the greatest opportunity to reconcile the requirements for erosion control and irrigation-water application. Slope reduction often effectively reduces the volume storm runoff from a field making more effective use of the rainfall that occurs during the growing season and thus reducing the irrigation-water requirement. It permits the growing of many crops which are difficult to irrigate on steep slopes. Higher fertility levels and crop yields can be maintained through reduced erosion losses. It generally permits the use of more efficient irrigation methods and longer irrigation runs.

In some climatic areas and with certain soils, slope reduction can be carried only to a point where wetness will not become a limiting factor to production. The most favorable slope is the lowest that will provide adequate surface drainage.

Contour bench leveling provides a method of altering the topography of a field to reduce the slope to the most desirable grade, thus controlling erosion, simplifying irrigation water application, and providing adequate surface drainage. With contour bench leveling the field is broken into relatively narrow strips which follow the approximate contour, and each strip is leveled so that there is a predetermined longitudinal grade and no transverse slope. Contour benches can be constructed to permit

TABLE .--Factors Influencing the Selection of a Method of Applying Irrigation Water[1]

Method of applying irrigation water (1)	Major Influencing Factors				
	Effective growing season rainfall (2)	Intake rate and capacity for available water in soils (3)	Topographic relief and soils (4)	Crops to be irrigated (5)	Cost of applying water (6)
Furrow	Hazard of erosion down steep slope	Adaptable to most all soil textures	Uniform slopes of from 0.25% to 2.5%	Row crops (sugar beets, corn, cotton, vegetables, sugar cane, etc.)	Most economical when uniform slopes are not over 2.5%
Corrugations	Can be used on comparatively steep slopes and heavy rainfall	Fine textured soils with low intake	Irregular fields, short runs, and slope up to 8.0%	Close growing crops (grains, hay, and some vegetables)	Most economical in first cost. Requires moderate labor
Borders	Can distribute water rapidly. Not damaged by heavy rains	Not desirable on fine textured soils with low intake rate	Smooth uniform slopes of not over 3.0%	Small grains, hay and pasture	Economical where heavy land grading not required. Moderate labor required.
Basins	Will accommodate heavy rainfall with required drainage	Adaptable to all soil textures	Level land	Most all crops. Only method for rice.	Where heavy land leveling not required costs are moderate. Labor costs are minimum
Flooding	Heavy rainfall permissible	Coarse to medium textured soils with high intake rate	Irregular fields and topography with slopes up to 8.0%	Pasture or native hay	First cost very low. Annual labor high for 100% coverage
Sprinkler	Heavy rainfall permissible	All soils but particularly good or coarse textured soil	Undulating topography permissible with slope of no consequence	All crops except rice	First cost, annual O & M and labor costs are high
Subsurface	Rainfall no item with controlled subsurface drainage	Loam or sandy loam soils with good lateral movement of water	Surface should be smooth and parallel to water table	Most all crops except orchards and rice	Minimum first cost and minimum labor cost

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[1] This table to accompany article by P. H. Berg (see page 20).

level as well as graded irrigation methods.

One of the major disadvantages to contour bench leveling is that a ridge and escarpment area is necessary between strips, and since they are not cultivated, a certain percentage of the area is lost to production of the field crop. Weed control may be difficult during the first few years until permanent vegetation can be established. In many areas a rodent control program must be initiated to prevent breaks. By the very nature of the contour system, flood runoff and irrigation waste water are accumulated high on the slope, and some method of water disposal must be provided to safely lower the excess water from the benches to a stable grade. Either grassed waterways, structural measures, or both may be required to handle this problem.

Contour bench leveling is applicable to deep soils on relatively smooth slopes. The maximum slope upon which it can be successfully installed will vary with the type and value of the crop to be grown, the farm equipment to be used, and the managerial ability of the farmer.

The planning of a contour bench system is the most difficult step in its establishment. Each bench may be considered to be a separate field which must have a water supply system, drains, access roads, and fit into the management plan for the farm.

SCS, USDA, Lincoln, Nebr.

Epstein, G. FIELD ANALYSIS OF FURROW IRRIGATION IN ORCHARDS. J. Soil and Water Conserv. 15: 221-225. 1960.

A method of analysis has been developed to evaluate existing conditions under which irrigation is practiced in a particular field. By this method, when inefficiencies in irrigation management exist, adjustments can be made to fulfill the irrigation requirements more efficiently.

An orange grove was selected and determinations made of the consumptive use of water, the efficiency of irrigation, the duration of irrigation, and the intervals between irrigations during the 1956 and 1957 irrigation seasons. Analysis disclosed that under existing conditions irrigation efficiencies were low, water application was far in excess of the required replacement and the duration and intervals of irrigation were haphazardly decided.

During 1956, the seasonal application of water amounted to 49.3 acre-inches per acre to replace a consumptive use of 15.9 acre-inches per acre. In 1957, irrigation management was changed and the seasonal application amounted to 29.6 acre-inches per acre to replace 18.3 acre-inches per acre of consumptive use. At the same time, the replacement of deficient moisture was very nearly 100 percent.

The analysis indicated that further, slight changes in management would bring the quantity of applied water closer to the water requirement. If this were done, assuming a seasonal consumptive use of 17 acre-inches per acre, about 25 acre-inches per acre of applied water would be needed. This would vary with the season, depending on climatic conditions.

This method of analysis may be applied with variations to any irrigated crop and field if the specific crop requirements, soil characteristics, climatic conditions, and irrigation water quality are considered.

SCS, USDA, Redlands, Calif.

Bennett, W. A. DRAGLINE IRRIGATION: FOR APPLE ORCHARDS. Soil Conserv. 26: 84-85. 1960.

Dragline sprinkler laterals can be used in orchards near Pateros, Wash.

The system was installed in the spring of 1959. The hydrant valve bases on the main water line were installed below ground level so that farm machinery, and particularly the dragline laterals, could pass over the hydrants without causing damage. Eight-inch concrete pipe was slipped over the valve bases flush with the ground to give further protection against damage from farm machinery.

The permanent trees in the orchards are planted on 28½-foot squares, adequate spacing for the semi-dwarf trees. Filler trees are planted in the centers of these permanent tree spacings, which makes a distance between rows of only 14¼ feet. Each orchard, rectangular in shape, is about 880 feet wide (east to west) and 1,320 feet long. The main water lines run underground down the center of the orchards, north to south.

It takes approximately 25 minutes to move the three laterals. This means that by using the dragline laterals instead of conventional portable aluminum lines, about $2\frac{1}{2}$ man-hours per day is saved during the irrigation period.

SCS, USDA, Okanogan, Wash.

Curtis, T. H. CHANGING IRRIGATION SETS BY THE CLOCK. Irrig. Engin. and Maintenance 10(12): 14-15. 1960.

Gravelly soils that need irrigation sets every three-quarters of an hour presents difficult irrigation problems. Mr. John Browning solved his problem on these soils by converting to border dikes and inventing mechanical devices that would control the water.

With the alarm clock as the trigger and the water pressure in the ditch as the force, a common canvas dam was converted into an automatic dam which would collapse at any set time. If one of these devices were installed in a head ditch opposite each border ridge, the water level in the ditch would be raised and forced into the adjacent strip of land. The timer could be set to release the dam after enough water had been diverted to irrigate that strip.

The next dam down the ditch then would catch the water and irrigate the next strip. In this manner, the whole field could be set up one evening and could be completely irrigated by the next morning.

The first refinement was an automatic border outlet "drop gate." This wooden "guillotine" was set in the ditch bank opening leading to the border strip, and was connected by a wire to the automatic dam. When the dam collapsed, the border outlet was closed at the same instant.

Two more gates were developed to do the same job as the automatic canvas dam. One is an all-steel structure to be set in an irrigation ditch. This features a center section hinged like a drawbridge. In a raised position, it forms a dam in the ditch. Lowered, it serves as a floor below the dam to prevent erosion in the ditch bottom. The second is a similar steel device made adjustable to fit into the flashboard slots of an existing structure. All of these devices are made to be released by a timer, or to be installed in groups of two or more, which can be released by the same timer.

These automatic controls save both labor and water. The cost of one of these devices is less than a week's wages for an irrigator. The timer is the only delicate part, and it is enclosed in a waterproof case.

In adapting these devices to an existing system, each situation must be considered individually. Automatic controls of this type have a place in all irrigated areas, but are best suited where border irrigation is used.

SCS, USDA, Twin Falls, Idaho.

Pair, C. H. SPRINKLER IRRIGATION. U. S. Dept. Agr. L. 476, 8 pp. 1960.

An illustrated leaflet on the different types of sprinkler irrigation systems and their installation and use.

ARS, USDA, Inform. Div., Washington 25, D. C.

van't Woudt, B. D. REPORT ON FINDINGS FROM AROUND THE WORLD . . . IRRIGATION DEVELOPMENTS. Hawaii Industry 6(5): 50-51. 1960.

Dr. van't Woudt recently returned from a tour during which he studied irrigation methods around the world. This article discusses his findings and their application to irrigation in Hawaii.

Hawaii Agr. Expt. Sta., Honolulu, Hawaii.

Willardson, L. A. IRRIGATION IN LATIN AMERICA. J. Irrig. and Drain. Div., ASCE 86(IR 3): 101-111. 1960.

Irrigation agriculture in Latin-American countries needs technological guidance to utilize the potential of unusual tropical conditions. Non-uniform annual distribution of rainfall combined with good soils and a 12 month growing season favor a high level of agricultural development. Supplemental irrigation, coupled with drainage of excess rainfall during wet seasons is one of the keys to successful development. Education of farmers and landowners to the acceptance of modern technology is another important key. A variety of experience from these three representative countries (Honduras, Dominican Republic, and Puerto Rico) is available which proves that irrigation in the tropics can raise the level of agricultural production with beneficial results.

SWCRD, ARS, USDA, Logan, Utah.

Boyer, M. C. IRRIGATION AND DRAINAGE POTENTIALS IN HUMID AREAS. J. Irrig. and Drain. Div., ASCE 86(IR 3): 51-61. 1960.

In the words of the demographers, the world's population is "exploding." If present growth rates continue to the year 2000, the population of the United States will have increased approximately 1.82 times. Communist China 2.16 times, and other areas of the world by like amounts. It is estimated that by the year 2000 the United States will be producing approximately one-third more food than needed for its own people, while Communist China and much of the rest of the world will be producing less than one-half the food needed. Under those circumstances mass starvation would be inevitable. Civil engineers must accept the responsibility for making the cultivated lands yield most efficiently through proper irrigation and drainage, particularly in the humid areas of the world.

Hydraul. Engin., Ind. Flood Control and Water Res. Comn., Indianapolis, Ind.

Select Committee on National Water Resources United States Senate. WATER RESOURCES ACTIVITIES IN THE UNITED STATES. 86th Congress, 2nd Session Committee Print 14, 45pp. 1960.

Irrigation has played an extremely important role in the development of the West. It provided the means for making many areas of the West suitable for settlement, and it created a frontier in which people could find opportunity for profitable self-employment. With irrigation came many attendant benefits such as highways, railroads, schools, and community integration and development. Numerous vital centers throughout the West owe their present existence almost exclusively to irrigation.

In 1958 there were about 34 million acres of irrigated land in the United States, of which some 30.5 were in the 17 reclamation States. Of the 30.5 million acres, about 24 million are dependent upon privately developed facilities and 6.5 million upon federally constructed works. More than 80 percent of private development has been from natural flows and ground water with the remaining from reservoir storage. The limit of development from simple gravity diversion of natural flows has for all practical purposes been reached, and the remaining potential irrigation expansion from ground water is relatively small. Future expansion of irrigation in the West will depend primarily upon the more expensive reservoir storage and high-lift pumping type developments characteristic of the Federal reclamation program and the proposed California State water plan.

The doubling of the Nation's population in the next 50 years means that twice as much food and other farm products will be needed to maintain present dietary levels. Advancing standards of nutrition will call for more protective foods. Present crop output will need to be doubled and livestock products more than doubled. There will be a demand for the maximum output that can be secured from the agricultural plant. The increasing population, moreover, will need living space and economic opportunities. The entire economic base of the West will need to be broadened if it is to absorb and provide for its share of the expected population growth.

Irrigation expansion can contribute importantly to all of these objectives. Looking to the year 2000, the foreseeable needs for food and fiber and new economic opportunities will require the greatest practical acreage of land in the West that can be reasonably and economically irrigated. There will be need also for the benefits flowing from hydroelectric power, flood control, municipal and industrial water supply, recreation, fish and wildlife, and all other functions that are associated with, and a part of, reclamation development.

Development of the full physical irrigation potential of the West will never be realized, as factors such as excessive cost, competition by other functions for water, lack of interest, and limitations on water export will always preclude some potential development. It appears reasonable and within economic reality, however, that of the 1,085 projects summarized in this report, 75 percent of the Federal projects and 90 percent of the non-Federal projects could be developed by the year 2000. Such a program would provide for the irrigation of 17 million acres of new irrigated land equivalent at an estimated cost of $22 billion.

Tables, maps, and graphs.

Bur. Reclam., U. S. Dept. Interior, Washington 25, D. C.

Drainage

Sisson, D. R. BETTER FARM DRAINAGE NEEDED! Crops and Soils 13(1): 12-14. 1960.

The three principal methods of field drainage are: tile, open ditch, and surface drainage. A good outlet is the foundation for any of these methods. If a good outlet is not available for gravity flow, pumping may be necessary.

There are few situations where tile drainage alone is the complete answer and there are situations where tiling should not be used.

Relatively deep (3 to 5 feet) open ditch channels not crossable by farm machinery may be used for both surface and soil drainage. They usually are not used for field drainage except in certain unstable soils where tile drains are too great a risk.

Surface drainage is an important development in farm drainage. More emphasis is being placed on surface drainage of slowly permeable soils, either to supplement tiling, or alone where tiling cannot be used profitably because of tight subsoils or lack of a suitable outlet. Surface drainage is usually accomplished by some combination of shallow ditches, land smoothing, land grading, shaping, or forming. These ditches are relatively shallow and are usually crossable with farm machinery.

The general types of surface-drainage systems are: Parallel ditch, bedding, random ditch, and cross-slope ditch (drainage-type terraces).

The parallel-ditch system is suitable for flat, poorly-drained soils with numerous depressions. They fit well with the use of large farm machinery.

The bedding system is one of the older surface-drainage systems that is not convenient to farm with modern machinery and usually will not give as complete drainage as the parallel-ditch system.

The random-ditch system is adapted to slowly-permeable soils with pockets or depression too deep or large to fill by smoothing or shaping. The random ditch meanders from one low spot to another.

The cross-slope ditch system resembles terracing. The drainage ditches follow around the slope on a uniform grade according to the lay of the land. The system is for both drainage and erosion control on sloping wet fields (4 percent or less) where internal drainage is poor from the plow sole downward and where many shallow pockets hold water after rains. Best drainage will result if rows run in direction of greatest slope.

Each of the surface-drainage systems, except the random-ditch system, require collection or interception ditches to carry runoff outlet ditches.

Land smoothing will increase the effectiveness of all surface-drainage systems. The smoothing not only increases the effectiveness of drainage but it makes all tillage, planting, cultivating, and harvesting operations more efficient. Land smoothing provides a uniform surface that drains easily. This practice fits well with medium-tillage farming. Land smoothing can be used to provide a system for both drainage and irrigation.

A new practice in drainage is the use of a fiberglass filter to cover tile lines and prevent clogging in fine sandy or silty soils.

A plastic-lined mole drain is a new idea being widely tested. The cost is about 10 cents a foot and it is expected that the plastic lining will give the mole drains much longer life than they have without it.

Good quality clay or concrete drain tile is still the best bet for subsurface drainage. A recent research finding is that tile lines can be joined at 90-degree angles without slowing the water flow.

A good soil conservation program and other soil-improving practices are required to obtain best efficiency from any drainage system. There still is no substitute for deep-rooted legumes to improve soil structure and drainage.

Purdue U., Lafayette, Ind.

Butler, E. D. LAND LEVELING IN THE ARKANSAS DELTA: ENGINEERING PRACTICES RECOMMENDED FOR SERVICING LANDOWNERS. Agr. Engin. 42:128-131. 1961.

Approximately 10 million acres of nearly level, deep, fertile bottomland soils underlain with abundant water-bearing sand are in the Delta area of eastern Arkansas. The average annual rainfall is about 50 in.; however, records show that drought periods are frequent during the average growing season.

The area consists mostly of deep, medium or fine-textured, slowly or very slowly permeable bottomland soils. The average intake rates are extremely low, being from 0.15 to 0.30 in. per hour for a 3-in. application of water. At saturation, these soils have an intake rate very near to zero.

Land-leveling design criteria is balanced between the conflicting needs for drainage and irrigation. Grades between 0.1 and 0.3 ft. per 100 ft. are recommended.

Drainage systems must always be planned in conjunction with irrigation systems. Field dimensions are usually determined by required location of drainage ditches rather than from irrigation requirements. Because of the depth of the soil and the relatively flat topography, the depth of cut is seldom a problem.

The average cost of land leveling has been about $75 per acre for moving about 350 cu. yd. per acre. Some land has been leveled where as much as 1,400 cu. yd. per acre were moved. It is believed that the benefits from irrigation and drainage will justify expenditures for land leveling up to $200 per acre on most soils under present conditions.

It is possible to service the maximum number of landowners with SCS resources by means of the following practices: (1) Extensive use is made of helpers furnished by the landowners; (2) plantation personnel are trained to obtain survey data and to mark cut and fill stakes; (3) land-leveling contractors are encouraged to own and use their own levels to check progress of leveling operations; (4) a short-cut method called the "average profile method" is used for calculating the plane of best fit; and (5) a form is used to systematically organize and record computations and check for mathematical errors.

SCS, USDA, Little Rock, Ark.

King, A. L. DRAINAGE, A VITAL NEED IN IRRIGATED HUMID AREAS. J. Irrig. and Drain. Div., ASCE 86(IR 4): 81-100. 1960.

Even in humid areas, all sections experience droughts, and supplemental irrigation may be used to advantage, if economically feasible and if an adequate water supply is available. Rain does not fall in many cases in proper amounts or at the times needed, although it may be adequate as far as total amount is concerned. Many rains fall in such amounts and at such excessive rates that adequate drainage for the protection of crops is required for optimum yields. It must be stressed that irrigation, without adequate drainage, may be a detriment rather than an aid. Irrigation, if practiced throughout the year, keeps the soil in optimum condition and permits the growth of suitable crops in all seasons, thereby raising the standard of living in humid areas. The very rapid increase in world population makes it necessary that we have a similar increase in food production and the logical solution of the problem is to increase production in the most fertile areas near population centers. The engineer must and will meet the challenge.

Weather Bur. Off., Memphis, Tenn.

Sutton, J. G. INSTALLATION OF DRAIN TILE FOR SUBSURFACE DRAINAGE. J. Irrig. and Drain. Div., ASCE 86(IR 3): 27-49. 1960.

Current progress in installation of tile drains for subsurface drainage is reported. The Soil Conservation Service provided technical assistance on installation of 24,059 miles of tile drains during the 1959 fiscal year. The paper gives benefits of tile drainage, and describes tile used in combination with surface drainage and current procedures used by the Soil Conservation Service in making drainage investigations. Recent changes in the American Society of Testing Materials specifications for clay and concrete drain tile are discussed. Recommendations are given for use of concrete tile under acid and alkali soil conditions. Recommendations for gravel filter requirements are given.

SCS, USDA, Washington 25, D. C.

Brooks, D. R. HAND LAYING CONCRETE DRAIN TILE IN OPEN DITCHES. Irrig. Engin. and Maintenance. 10 (11): 8-9. 1960.

This article tells how Jake Verboon hand-laid concrete drain tile in open ditches over unstable soil material. By the use of a special form that reduced the amount of filler needed, the cost was comparable to machine-laid tile. Machine-laid tile on these unstable soils had proved to be unsatisfactory.

SCS, USDA, Hanford, Calif.

Nelson, R. W. FIBERGLASS AS A FILTER FOR CLOSED TILE DRAINS. Agr. Engin. 41: 690-693, 700. 1960.

The use of sand and gravel envelopes or filter materials around tile drains has long been recommended in the irrigated areas of western United States to facilitate water entry and prevent soil from entering the tile drainage system. Sand and gravel materials have been widely used with costs usually ranging from 25 to 65¢ per lineal foot. Recently fiberglass materials have become available commercially at a price of less than 5¢ per foot.

The purpose of the research reported in this paper was to determine what soil sizes would not move through the fiberglass material into the tile line.

The original fiberglass material containing only longitudinal uniform reinforcing has insufficient lateral strength. This combined with poor filtering characteristics make it unsatisfactory for general use. The improved fiberglass containing random fibers for reinforcing performed satisfactorily. The following are the specific conclusions from this paper: (1) Based on samples of the improved material tested, the amount and size of soil particles of any field sample which will pass through the fiberglass material can be estimated through use of a graph given and the mechanical analysis of the sample being examined; (2) the conservative stability criteria recommended for general use is that the 50-percent size from the mechanical analysis shall be greater than, or equal to, the average diameter of opening in the fiberglass sheet; (3) a simple method for determining whether the improved fiberglass will adequately prevent the particular field soil being examined from entering the drainage system is presented by a graph; and (4) when installing a sheet or roll of fiberglass laid over tile, it must be completely covered by at least 2 in. of hand-placed top soil to insure against damage during machine backfilling.

With machine backfilling, 2 to 4 inches of soil should be placed over the sheet manually in order to insure against tearing and breaking of the fiberglass material. When used with this precaution, the use of the fiberglass material can result in reduced installation costs.

SWCRD, ARS, USDA, Fort Collins, Colo.

Jones, B. A., Jr. EFFECT OF CRACK WIDTH AT TILE JOINTS ON SOIL MOVEMENT INTO DRAINTILE LINES. Trans. ASAE 3(1): 33-35, 41, 54. 1960.

The effect of width of crack at tile joints on the amount of soil moved into tile lines was studied in the laboratory.

The surface 6 to 8 in. of a sandy loam, silt loam, and silty clay loam soil was packed at different times in a profile tank, and crack width between tiles of 1/18, 1/8, and 3/16-in. were tested.

The following conclusions were reached: (1) Soil enters the joints at the bottom of the tube below the air-water interface. (2) The soil moved at the joints as a result of the energy supplied by the drainage water moving into the joints. (3) A joint itself disturbs flow very little, and the disturbance has very little effect on soil movement. The main function of water flowing by a joint is to carry soil particles away as they are pushed in. (4) For the silt loam soil that was tested, a 1/16-in. crack width is the largest crack that should be installed. (5) For the silty clay loam soil that was tested, a 1/8-in. crack width is the largest crack that should be installed. And (6) a submerged outlet increases the quantity of soil discharged from 30 to 100 percent as compared with the soil discharged from a free outlet.

U. Ill., Urbana, Ill.

Jager, A. W. De. REVIEW OF PLASTIC DRAINAGE IN THE NETHERLANDS. Netherlands J. Agr. Sci. 8: 261-270. 1960.

A description of drainage circumstances and the possibilities of mole drainage is given, followed by a review of the experiences with plastic drainage in The Netherlands.

Polyethylene tubes are pulled behind a mole plow from the ditch side into the subsoil, plastic strips are laid with a specially designed mole plow and plastic pipes are installed with a conventional machine for tile drainage.

Field experiments and sand tank investigations were made with plastic strips and plastic pipes showing sand infiltration and drainage discharge. In the case of plastic pipe a comparison was made about drainage results between different perforated plastic pipes and normal tile drains.

The most important advantage of plastic pipe drainage is its high degree of mechanization leading to an increase in labor-productivity. Costs of transport are negligible in comparison with ordinary tiles.

Res. Div., Nederlandsche Heidemaatschappij, Arnhem, Netherlands.

Cutler, W. A., Wheaton, R. Z., and Kidder, E. H. DRAINAGE SYSTEM ENDURANCE IN ORGANIC SOILS. Agr. Engin. 42: 79-81, 85. 1961.

In a seven year study of tile drainage on Houghton muck with four types of concrete tile, galvanized steel pipe, and bituminous fiber pipe the author made the following conclusions: (1) The soil surface subsidence was 0.4 to 1.0 feet the first year following drainage with little subsidence the following six years; (2) the tile settled about 0.3 feet the first year following drainage ,with very little change in the next six years; (3) three of the four manufacturers' concrete tile showed deterioration in quality in four years; (4) rusting was observed on the galvanized steel pipe; (5) a slight flattening of the bituminous fiber pipe occurred; and (6) the marsh hay blinding material remained in excellent condition for six years.

Mich. State U., East Lansing, Mich.

Evaluation of Flood Water Damage

Staff Writer. CORPS URGES MORE FLOOD SPENDING. Engin. News - Record. 165 (21): 26. Nov. 24, 1960.

An $11.5-billion, 20-year program of flood-control construction is proposed by the Corps of Engineers in a study report released by Sen. Robert S. Kerr (D., Okla.).

Increasing the current $300-million-a-year appropriation for flood control exclusive of multiple-purpose projects to $500 million by 1970 and holding it at least that high through 1980 would finance the needed works, the report says.

The Engineers estimate that losses for major U.S. flood areas will climb to $960 million a year by 1980 if no additions are made to the flood-control system now in operation. Average annual losses now total about $700 million.

The stepped-up program outlined in the report would cut 1980 flood-plain losses to $483 million. This reduction would be attained by investment of $11 billion in dams, levees, floodwalls, and channel improvements. An additional $500 million would be expended during the same period to protect coastal areas against hurricane-driven floods.

Over-all, the projected expenditures include $2 billion to complete projects now under construction, $3 billion to build works authorized but not yet started, and $6.5 billion for additional future projects that now appear justifiable.

To date, the Army Engineers have spent $3.8 billion for flood-control construction: $1.35 billion of completed projects, plus nearly $2.5 billion of construction put in place on projects still under way. Today the existing works are saving an average of $500 million a year in flood losses and so far have prevented an estimated total of $9 billion.

Completed or under construction are 219 dams and reservoirs, providing 87 million acre-ft. of flood storage, and more than 9,000 miles of levees and floodwalls.

Authorized projects awaiting construction would add 121 dams and reservoirs, with 40 million acre-ft. of flood-control capacity, and 3,000 miles of levees and floodwalls.

To these, the projected 20-year program adds proposed projects, now judged practicable, involving 400 reservoirs with 64 million acre-ft. of flood storage and 4,200 miles of levees and floodwalls.

Army Engineer flood loss estimates apply to all downstream areas and to those portions of the upstream watersheds where the Corps has flood-control responsibilities.

Senator Kerr said the report shows that the nation can deal effectively with floods. The pace of flood plain development now is raising flood damage potential faster than construction of control works is reducing it.

Engineering News-Record, 330 W. 42nd St., New York 36, N. Y.

Storage and Conveyance

Cutler, W. A., and Grigsby, B. H. CONTROL OF CATTAIL AND OTHER VEGETATION IN DRAINAGE DITCHES. Trans. ASAE 3(1): 66-67. 1960.

Drainage ditches are designed to discharge or convey calculated amounts of runoff from surface and subsurface sources. The surface condition of the sideslopes and the bottom of the channel must be considered in determining the roughness coefficients which are used in channel flow formulas. The desirable and most economical lining for a drainage ditch is a grass cover free from upright rigid growth. Brush, weeds, and cattails increase the magnitude of the roughness coefficient so that its value vitally affects the velocity of flow.

The elimination of brush and weeds on the side slopes of the channel is necessary in order for the grasses to form a smooth blanket on the slopes and eliminate friction losses caused by the interference to flow. Brush and weeds also will compete with the grasses for plant food and sunlight and make it harder to establish the grasses after seeding.

The control of woody vegetation by the use of foliage sprays or of dormant basal treatment with mixtures of 2-4-D and 2-4-5-T is routinely practiced on fence rows, rights of way, and other non-agricultural land. This method is also being adapted to the control of brush in drainage ditches. Observations of areas sprayed for brush control indicate that the development of a grass cover is rapid where satisfactory control of other vegetation is obtained. In areas where cattails are present, the water-flow problem is not solved by the control of woody or upright herbaceous growth.

Tests over a three-year period have shown that it is possible to eradicate cattail with dalapon. A single-spray application, in June or July, of 13.6 lb. of dalapon was effective in killing the growth present at the time of treatment, and in preventing regrowth in the succeeding two years.

Spray applications with either hand guns or cluster-nozzle booms have been equally effective.

Dalapon is a widely used grass killer and is effective on perennial grasses at somewhat lower dosages than were used on cattails. Because of this grass toxicity, it is necessary to exercise some care in spraying ditches for cattail control. Careless application or accidental spraying of ditch banks may lead to the destruction of a native grass cover and thus contribute to unwanted erosion of the exposed slopes. This erosion can cause a considerable amount of sediment accumulation in the ditch bottom which will reduce the water-flow capacity of the ditch, perhaps nearly as much so as the untreated cattails.

While the inclusion of 2-4-5-T or silve apparently speeded up the response of the cattails to dalapon, such use is seldom required. Any woody growth in a ditch should be removed and killing of this growth is of secondary importance.

Mich. State U., East Lansing, Mich.

Anderson, J. R. VINYL FILM LINER FOR EARTH-FILL RESERVOIRS. Civil Engin. 30(6): 42-43. 1960.

Finding an ideal liner for earth-fill reservoirs has long been a problem for engineers and advocates of water conservation. It is generally agreed that the ideal liner should be: (1) Impermeable to water; (2) reasonably durable; (3) flexible over a wide range of temperature; (4) resistant to mechanical damage, weathering, and deterioration; (5) low in cost; and (6) easy to install. These qualities are particularly important in the arid and semi-arid parts of the nation and are very necessary where the available earth materials are free draining.

A black 8-mil vinyl film liner was installed in three reservoirs in South Davis County Water Improvement District, Utah, in 1959. The reservoirs have capacities of 1, 5, and 9 acre-ft. and serve as equalizing storage for three separate pressure units. They provide irrigation water for 1,000 acres of land in the rolling foothills of the Wasatch Mountains.

The installation of the plastic in the three reservoirs is described.

The result is a very neat appearing reservoir, completed in a minimum of time, and at a relatively low cost. The cost of the liner in place was $0.475 per sq. yd.

The performance that can be expected from vinyl film linings was demonstrated during the construction and testing of the reservoirs. No losses above normal evaporation were noted. The material remained very flexible, even when the temperature dropped to freezing. The liner appeared to be very durable; there was very little damage during installation. The low cost of the material, along with the low cost and ease of installation, provided further evidence of its utility.

Project Engineer, Nielsen, Reeve and Maxwell Inc., Ogden, Utah.

Lauritzen, C. W., IN AREAS OF LOW RAINFALL, THE ANSWER TO THE PROBLEM OF WATER SHORTAGE MAY BE GROUND COVERS FOR COLLECTING PRECIPITATION. Farm and Home Sci. 21: 66-67, 87. 1960.

The performance of materials, developed recently, indicates that in some areas water can be collected by ground covers at a cost which will be competitive with other water sources. Materials evaluated have included plastic films--vinyl and polyethylene--butyl rubber sheeting, asphalt-coated jute fabrics, and chemical sealants. Of these butyl sheeting and asphalt-coated jute material look most promising.

Trouble with seam failure due to wind action was encountered with polyethylene film when used as ground covers. Bird damage was also a problem. Ground covers of vinyl film were much less susceptible to wind and bird damage, but after about two years of service the vinyl films began to develop holes due to migration of the plasticizer. Plastic films of 8 mil or thinner were tested, while 25 mil butyl sheeting was used.

Runoff from soil surfaces can be increased by treatment with certain chemicals.

Cost of Developing Water by Means of Ground Cover*

Annual precipitation	Life of cover	Cost per 1,000 gallons	Cost per acre foot
Inches	Years	Dollars	Dollars
8	10	3.10	1,020
12	10	2.08	680
18	10	1.37	447
8	15	2.32	760
12	15	1.54	503
18	15	1.03	337
8	20	1.93	630
12	20	1.29	423
18	20	.86	283

*Assuming ground cover in place costs $1.00/sq. yd.

Ground covers look promising as an approach to water development in some areas. As less expensive and better materials are developed, the cost of water developed by this method will be correspondingly reduced.

SWCRD, ARS, USDA, Logan, Utah.

Wilder, C. R. UNDERGROUND PIPE LINES FOR IRRIGATION AND DRAINAGE. Trans. ASAE 3(1): 65, 67. 1960.

Preventing waste and loss by seepage of irrigation water is of great importance in the West. Lining irrigation canals and ditches reduces seepage, waste, maintenance costs, weed problems, and permits more convenient and economical operation. Underground concrete pipe lines not only have all of the good points of lined ditches, but the following additional advantages as well: (1) Evaporation is eliminated; (2) weeds and insects are practically eliminated; (3) cultivation can be carried on over the pipe line right of way; and (4) pipe lines can operate under pressure. These advantages over open surface ditches, unlined and lined, have resulted in a steady growth in the use of concrete pipe.

In many irrigated areas, drains must be installed to preserve the land's productivity.

It is logical to consider both the irrigation and drainage uses of concrete pipe at one time, since (a) similar manufacturing processes are applicable to both, and (b) similar hydraulic laws apply to their design as water-conveyance facilities.

Installation and use of concrete pipe for irrigation and drainage are dismissed. Care must be used to obtain proper bedding and jointing of underground concrete pipe and in back-filling operations. Finally, water should be placed in completed pipe lines (closed joints) within 36 to 72 hrs. after laying, so that pipe can expand before mortar joints have set.

Conserv. Engin., Portland Cement Assoc., Denver, Colo.

Mansfield, W. W. THE INFLUENCE OF MONOLAYERS ON EVAPORATION FROM WATER STORAGES: *

* I. THE POTENTIAL PERFORMANCE OF MONOLAYERS OF CETYL ALCOHOL. Australian J. Appl. Sci. 9: 245-254. 1958.

* II. EVAPORATION AND SEEPAGE FROM WATER STORAGES. Australian J. Appl. Sci. 10(1): 65-72. 1959.

* III. THE ACTION OF WIND, WAVE, AND DUST UPON MONOLAYERS. Australian J. Appl. Sci. 10(1): 73-84. 1959.

* IV. THE SPREADING OF MONOLAYERS FROM SOLIDS. Australian J. Chem. 12: 382-393. 1959.

A series of technical papers of detailed study of the influence of monolayers of cetyl alcohol on evaporation from open water (ponds and lakes).

The author summarizes each technical paper as follows:

I. It is estimated that permanent and complete application of a molecular film of cetyl alcohol to the surface of a water storage should reduce annual evaporative losses by 50 percent or more. The effects of varying atmospheric conditions on the ability of such a film to reduce evaporation are outlined.

II. The influence of depth of water upon the annual evaporative cycle of a water storage is estimated. The relations between storage evaporation and losses from an evaporimeter are outlined. It is shown that seepage losses from a storage may be determined from variations in its total chloride ion content.

III. The nature of the ravages of wind, wave, and dust upon monolayers spread upon exposed surfaces of water are examined and some estimates are made of the resulting average losses of material from a monolayer of cetyl alcohol.

IV. It is shown that the nature and the rate of spreading of a monolayer from a solid depends upon the state and extent of the solid source and upon the hydrodynamic resistance to spreading. Experimental data describing spreading from solid cetyl alcohol are presented.

Commonwealth Sci. and Indus. Res. Organ., Chem. Res. Lab., Melbourne, Australia.

Bethlahmy, N. REDUCING EVAPORATION FROM SMALL RESERVOIRS. Northwest Sci. 33(3): 135-138. 1959.

The problem of evaporation is particularly acute in arid climates. In August 1957, the city of Dallas, Texas, lost eight billion gallons of water through evaporation--60 percent more than the total quantity used by its citizens during that month.

Because water is so precious, it is important that evaporation losses be restricted or eliminated. This can be accomplished by storing water in underground reservoirs, closed containers, deep pools with small surface areas, and by the use of chemicals spread over the evaporating surface.

Hexadecanol (cetyl alcohol) appears to be one of the most promising chemicals. Each molecule of hexadecanol is a long chain of carbon atoms whose ends behave differently toward water; one end of the chain is attracted to water, whereas the other end is repelled. As a result, when hexadecanol is scattered over a surface of water, its molecules align themselves vertically, side to side, and form a thin film over the surface.

In the summer of 1957, the Pacific Northwest Forest and Range Experiment Station instituted an experiment near Portland, Oregon, to evaluate the effectiveness of hexadecanol in reducing evaporation.

Two standard Weather Bureau pans (four feet in diameter, 10 inches deep) were placed side by side, and one was treated with hexadecanol. The powdered chemical was applied six times at irregular intervals, varying from seven to 36 days. The applications were made after heavy rainstorms or when additional water was added to the pan to restore its original level.

The results of the experiment definitely show that hexadecanol will reduce evaporation from a body of water. For the period studied, the effect of the treatment was to reduce evaporation by 42 percent. During the day hexadecanol reduced evaporation by 55.5 percent, but at night the reduction was only 18.8 percent.

Assume a summer water shortage in the vicinity of Portland, Oregon. Average daily evaporation from a pan amounts to 0.166 inches. The loss from a reservoir would be 70 percent of this figure, or 0.116 inches. On a one-acre reservoir this depth of evaporation is equivalent to 3,150 gallons. The use of hexadecanol would reduce this loss to 1,827 gallons a day, thereby effecting a daily saving of 1,323 gallons, or approximately 10,000 gallons a week.

Beadle and Cruse (1957) estimate that with an application rate of 2.2 lbs. of hexadecanol per acre, the cost of saving 1,000 gallons of water is only ½ cent. In Portland, the price of 1,000 gallons of water is 18.7 cents. During times of water shortage, farmers, ranchers, and municipalities in the Pacific Northwest would benefit greatly from the water savings effected by the use of hexadecanol.

Pacific Northwest Forest and Range Expt. Sta., FS, USDA, Portland, Oreg.

Brown, L. N. SMALL EARTH DAMS. Calif. Agr. Expt. Sta. Ext. Serv. Cir. 467, 23 pp. 1958.

About 10,000 small earth dams have been built on California farms in the last 20 years and more are being built all the time. While many of the early dams were built primarily as stock-watering ponds, farmers are also deriving benefits from their reservoirs in the way of irrigation water and even recreational purposes.

But dams have disadvantages too. They are expensive to build; they require labor and more expense to maintain properly; and they may increase the nearby mosquito population.

This circular discusses: (1) The laws involved--some are restrictive, some are beneficial, but you should know them. (2) Selection of a site--for the dam, the reservoir, and the spillway. You'll undoubtedly have to compromise. (3) Construction details--there are a lot of things to watch if your dam is to be a good one. (4) Maintenance practices--for the dam, the spillway, the reservoir, and the watershed. And (5) management practices--for both practical and recreational uses of the reservoir.

Dam building is a very involved undertaking. This circular endeavors to supply practical suggestions which may be of assistance with building, management, and construction.

Calif. Agr. Expt. Sta. Ext. Serv., U. Calif., Berkeley, Calif.

Ourada, M. J. HOW TO BUILD A FARM POND. Land & Water Conserv. 2 (10): 16-21. 1960.

Few farms can be operated successfully without an adequate water supply for livestock, irrigation, fire protection, spraying, or other farmstead needs. It has been proved that a well-planned pond contributes to greater farm earnings and soon pays for itself.

In localities subject to seasonal droughts, a good pond can mean the difference between success and failure by providing for crop and livestock needs when wells and springs run dry. In areas of heavy rainfall, farm ponds have an important function in soil conservation. They help check erosion and the formation of land-wasting gullies by preventing quick runoff. Combined with other sound soil conservation practices such as contour plowing, terracing, and strip cropping, farm ponds add to the value of the farm.

This is a complete "how to do it" article on building a farm pond.

Armco Drainage & Metal Products Inc., Middletown, Iowa.

Lane, K. S., and Fehrman, R. G. TUTTLE CREEK DAM OF ROLLED SHALE AND DREDGED SAND. J. Soil Mechanics and Found. Div., ASCE 86(SM 6): 11-35. 1960.

Construction at Tuttle Creek Dam has clearly shown the practicality of placing the sand shell in a modern earth dam by dredging directly into the embankment, and also the high caliber compacted fill which can be produced from a mixture of shale and limestone by proper combination of breakage in blasting and manipulation on the fill. The important principle of adapting embankment zoning to fit local materials governed the embankment design which worked out quite satisfactorily in the construction. The use of material unsuitable for rolled fill in traffic compacted berms was a definite economy which technique has also been applied at several of the large dams along the Missouri River. The opportunity for an economical spillway was a controlling factor in site selection which has similarly been the situation at numerous dams in the Great Plains region where soft rocks require costly spillways, but permit economical embankments.

Soils and Material Br., Mo. River Div., Corps of Engin., Omaha, Nebr.

Pugh, D. H., Jr. SPRING DEVELOPMENT FOR LIVESTOCK WATER. J. Soil and Water Conserv. 15: 270-271. 1960.

Farmers in Virginia are finding it necessary to develop their springs and seeps and they also find it profitable to use these meager sources of water. Probably the foremost reason for turning to spring and seep development is for a new source of livestock water supply. Wells are often uncertain and usually expensive. Good pond sites are not always present on the farm. And compared with spring or seep development, farm ponds are usually costly.

Another point in favor of spring or seep development is the reclaiming of valuable land for profitable production. The farmer makes operations more efficient by eliminating the wet spot that a spring or seep usually makes. In a real sense he acquires more land, and in many cases this is a sizable area.

In this paper a spring is defined as a natural flow of water from the ground surface, usually from a definite opening. A seep is similar to a spring but differs in that it has no definite opening.

In a spring development, the main objectives are to collect the water, store it, and make it available for use. This can be accomplished in three steps: (1) Cleaning out trenches into the water-bearing strata; (2) collecting the water in these trenches and leading it to a central point, known as a collection box; and (3) piping the water from this box to the point of use.

The development of springs and seeps is one of the most interesting and challenging engineering practices. It has also proven itself to be one of the most popular with the farmers where there is a need for more dependable supplies of livestock water.

SCS, USDA, Tappahannock, Va.

Doering, E. J. HORIZONTAL IRRIGATION WELL IN A SHALLOW, THIN AQUIFER. Trans. ASAE 3(1): 52-54. 1960.

A horizontal well, 77 ft. long, can be constructed in an aquifer whose bottom is 20 ft. or less below the ground surface by excavating a pit of sufficient size and depth with a dragline and lowering the horizontal pipe, with risers attached, into place as a unit.

Dewatering the pit during excavation is not absolutely necessary. By providing access to each end of the horizontal casing by means of risers to the surface, cleaning equipment can be put into the well to manually remove any sediment that might deposit in the horizontal casing during the development of the well.

This particular horizontal well is capable of producing 100 g.p.m. of water for 2.8 days. Such a yield is equivalent to the computed discharge of a vertical well whose radius is approximately equal to the length of the horizontal casing divided by π when the coefficients of transmissibility and storage derived from a pump test conducted on a sand-point well are used.

The cost of this horizontal well resulted in a cost of $11.10 per gallon per minute of water when based upon the computed 10-day yield. This cost for the well is higher than the cost usually encountered in eastern South Dakota where the aquifers are suited to the construction of vertical wells.

Information from well drillers indicates that the construction costs of vertical wells usually convert to a cost of from $1.50 to $2.50 per gallon per minute. Construction costs associated with this horizontal well appear to be prohibitive when compared to vertical-well costs in other areas on a cost per gallon-per-minute basis. However, it must be remembered that the vertical wells are being used in areas endowed with more extensive ground water supplies; and that even greater costs than $11.10 per gallon per minute can be justified if small acreages of high value crops are to be produced.

SWCRD, ARS, USDA, Riverside, Calif.

BASIC SOIL PROBLEMS

Soil Structure

Blake, G. R., Boelter, D. H., Adams, E. P., and Aase, J. K. SOIL COMPACTION AND POTATO GROWTH. Potato J. 37: 409-413. 1960.

Bearden sicl, a typical potato soil in the Red River Valley in Minnesota, was deliberately surface packed after seedbed preparation and before planting to observe its effects on potato growth and development. Observations were made in 1955, 1957, and 1958 with the following results recorded: (1) Packing treatments affected penetrability to the 12-inch depth measured. Average bulk density was increased from 1.04 to 1.17, during two years. (2) Easily drained pore space (air space at 60 cm tension) was reduced to approximately 9%, a value believed to be less than the thresh-hold value for adequate soil aeration. (3) Emergence of seed pieces was delayed, plant vigor was greatly reduced, and yields lowered two of three years by soil packing. The number of hills at harvest was unaffected by treatment. (4) Tubers set an average of about 1 inch nearer the soil surface on packed plots. The number of tubers set and percentage of misshaped tubers were the same for both treatments. (5) Specific gravity of tubers was higher on non-packed plots. This is believed to be caused by lower soil temperatures near the soil surface, greater tuber depth, better aerial canopy, or to some other factor that affected physiological maturity at harvest time. And (6) soil packing did not affect scab or silver scurf in the one year these diseases were observed.

U. Minn., St. Paul, Minn.

Triplett, G. B., Jr., and Tesar, M. B. EFFECTS OF COMPACTION, DEPTH OF PLANTING, AND SOIL MOISTURE TENSION ON SEEDLING EMERGENCE OF ALFALFA. Agron. J. 52: 681-684. 1960.

Field studies were conducted on a Conover sil and a Hillsdale sl, using a hand-planting microplot technique to evaluate the effect of the following on seedling emergence of alfalfa: 4 depths of planting (0, $\frac{1}{4}$, $\frac{1}{2}$, and 1 inch), 4 soil compaction treatments following planting (0, 3, 6, and 12 p.s.i.), and 2 moisture treatments following planting (no irrigation and $\frac{1}{2}$-inch irrigation). Initial emergence measured all emergence due to moisture present in the soil as a result of the two moisture levels. Total emergence was determined after the plots had received rain and included initial emergence plus subsequent emergence after rain.

Initial seedling emergence had a highly significant negative correlation with soil moisture tension determined one day after planting. No seedling emergence occurred when the soil moisture tension one day after planting was greater than 11 atmospheres on the Conover sil or 10 atmospheres on the Hillsdale sl.

When emergence was dependent on moisture present in the soil at the time of planting (no irrigation), increasing compaction from 0 to 12 p.s.i. and depth of planting from 0 to 1 inch improved moisture conditions around the seed. This resulted in a progressive increase in initial emergence except at maximum levels of seed depth and soil compaction on the sandy loam which crusted easily.

When plots were irrigated with ½ inch of water after planting, initial emergence was highest when seed was planted ¼ inch deep on the sandy loam and ½ inch deep on the silt loam soil. Emergence was greatly reduced when seeding depth was increased from ½ to 1 inch on the sandy loam. Increasing the degree of compaction improved emergence at all seeding depths on the silt loam and at the 0- and ¼-inch depth on the sandy loam; compaction was not beneficial at the ½- and 1-inch depths on the sandy loam.

Compaction increased total seedling emergence only when seeds were planted on the surface. The optimum seeding depth on both soil types was ½ inch. Total emergence was decreased as the depth of planting increased from ½ to 1 inch, especially on the sandy loam which crusted easily.

Planting alfalfa ½ inch deep with a soil compaction of about 6 p.s.i. following planting appears to be optimum for maximum emergence of seedlings under Michigan conditions. Deeper planting (½ to 1 inch) with increased compaction (6 to 12 p.s.i.) may be advisable under more arid conditions.

Mich. State U., East Lansing, Mich.

Mortensen, J. L., and Young, J. L. EFFECT OF SUMMER-SEEDED GREEN MANURES ON SOIL STRUCTURE AND AVAILABILITY OF NITROGEN. Ohio Agr. Expt. Sta. Res. B. 865, 31 pp. 1960.

Field experiments were established on Hoytville sic to determine if the major contribution of summer-seeded green manures was associated with improvement of soil structure or increased availability of nitrogen. VAMA soil conditioner (0.05%) and nitrogen fertilization (100 lbs. per acre) were compared by studying structure and nitrogen effects. Six summer-seeded green manures were used in a split-plot factorial design with corn in Experiment I, and sudan grass (1955), corn (1956), and oats (1957) in succession in Experiment II being the assay crops.

Stability of aggregates, aeration porosity, and volume weight were used as indices of soil structure. Plant population, nitrogen content of plant tissue and grain, number and weight of corn ears, and yield was made to determine the effect of the various treatments on the assay crop.

The following conclusions can be made from the results of this study:

1. There was no significant difference in the yield of the above ground portion of yellow sweet clover, red clover, alfalfa, ryegrass, or orchardgrass; but the nitrogen content of the grasses was low enough to cause immobilization of nitrogen in the soil when plowed under as a green manure crop.
2. Moisture content of the soil at plowing time was considerably reduced by transpiration of the green manures. Earlier plowing and/or better seedbed preparation could be expected if green manures were grown on heavy soils where moisture content at time of plowing influences the quality of the seedbed.
3. VAMA increased aeration porosity and aggregate stability, and reduced volume weight of the soil which was maintained through three growing seasons. Microbial activity was necessary before green manuring improved aggregate stability. Grasses were generally more effective in improving aggregate stability than legumes.
4. Nitrogen content of the plant tissue and grain was increased by nitrogen fertilization, and in some cases, by leguminous green manures. This effect was noted through a second growing season following nitrogen fertilization and/or green manuring. The grasses, and improved aggregation as the result of VAMA

treatment, reduced nitrogen content of the plant tissues. Additional nitrogen was required when soil structure is improved by conditioner treatment. Nitrogen fertilization at the rate of 100 lbs. per acre was insufficient to offset the unfavorable carbon/nitrogen ratio of the orchardgrass and ryegrass.

5. Nitrogen fertilization increased the yield of the first two assay crops but had no affect the third year after application. Leguminous green manures did not supply sufficient nitrogen for maximum crop yields.
6. During years of comparatively low rainfall, assay plants growing in conditioner treated plots matured more rapidly and yielded better than plants growing in untreated plots. In spite of the reduction in nitrogen availability, improvement in soil structure was positively correlated with increased yield in these years. Conditioner treatment had little effect on moisture equivalent, water-holding capacity, or field moisture content of the surface 6 inches of Hoytville sic. Improved soil structure probably increased yield in dry years by increasing the size of the available water reservoir.
7. Statistical analysis indicated that the components which affected corn yield most significantly were weight and number of ears. In dry years, improved soil structure increased plant population and the number and weight of ears. Nitrogen fertilization consistently increased these components of yield. The major effect of green manures on Hoytville sic with its present structural status was an increased availability of nitrogen. Yellow sweet clover gave the maximum benefit. Unless legumes can be sown in standing corn or drilled with spring grains, nitrogen could be more profitably applied in fertilizer form. When additional nitrogen was applied to offset the unfavorable carbon/nitrogen ratio, the grasses were the better green manure crops since they generally improved soil structure more than the legumes. This nitrogen would become available to crops following decomposition of the grasses.
8. The present price of synthetic soil conditioners prevents their use in general field applications for the improvement of soil structure. The use of summer-seeded green manures might be expected to have some favorable effect on the components of yield on fine textured soils when used prior to each cropping season. The immediate and residual effects on moisture content at time of plowing, and some improvement in soil structure and nitrogen availability would result in a better seedbed, improved stand, and increased yield, especially in dry years.

Ohio Agr. Expt. Sta. Wooster, Ohio

Stoeckeler, J.H. TRAMPLING BY LIVESTOCK DRASTICALLY REDUCES INFILTRATION RATE OF SOIL IN OAK AND PINE WOODS IN SOUTHWESTERN WISCONSIN. Lake States Forest Expt. Sta. Tech. Note 556, 2 pp. 1959.

Undisturbed forest soils, because of their high porosity, comparatively low bulk density, and rather deep surface organic layers, have an inherently high rate of infiltration.

This fact provides one of the most potent arguments for keeping steeper land in forest cover. However, when such forest land is subjected to trampling by livestock turned into the woods to graze, the infiltration rate of the soil is drastically reduced.

To obtain a measure of the relative reduction of infiltration rate due to intensive livestock use of the forests, a series of 48 infiltration tests were made. Steel cylinders 3 inches in diameter and 6 inches high were used. Twelve tests were made in each of four sites in the unglaciated region around La Crosse, Wis. Two sites were in native oak woods of sawlog size on loessal silt loam soil. Two others were in a Scotch pine plantation about 55 years old on a sandy loam soil. The cylinders were driven into the soil about 2 inches and then kept filled with water, with readings taken at 5, 10, 20, 30, 40, 50, 60, and 70 minutes thereafter. The infiltration rate for a

1-hour period excluding the first 10-minute wetting period is given below:

Cover	Infiltration in inches per hour
Ungrazed native oak woods	7.46
Grazed native oak woods	.05
Ungrazed Scotch pine plantation	11.02
Grazed Scotch pine plantation	1.23

Combining results of both areas, there is a 93-percent reduction in the cylinder infiltration rate due to livestock trampling.

The bulk density (apparent specific gravity) of the surface 3 inches of soil in the oak woods was 1.15 and 0.89 respectively for grazed and ungrazed conditions, representing a 29.2-percent increase in density of the soil due to compaction.

Lake States Forest Expt. Sta., FS, USDA, St. Paul, Minn.

McLintock, T. F. HARDPANS IN THE SPRUCE-FIR FORESTS OF MAINE. Proc. Soc. Amer. Foresters, Syracuse, N. Y.: 65-66. 1957.

A dense, compact, and virtually impermeable zone, occurring generally between 12 and 18 inches below the surface of the mineral soil, is characteristic of the glacial till soils of the spruce-fir region of Maine. This horizon appears to be a fragipan, and has a sandy- or silty-loam texture. Its average bulk density ranges from 1.50 to 1.80 but may go as high as 2.00. Above 1.50 it is impervious to root penetration except along occasional minute cracks. It is non-indurated, massive, hard, and brittle. Its presence perches a water table at varying times and for varying periods of the year, and contributes materially to susceptibility to windthrow of spruce-fir and associated species.

Southeastern Forest Expt. Sta., FS, USDA, Lake City, Fla.

Locke, L. F., Eck, H. V., Stewart, B. A., and Hass, H. J. PLOWPAN INVESTIGATIONS AT THE GREAT PLAINS FIELD STATIONS WOODWARD, OKLA., AND MANDAN, N. DAK. U. S. Dept. Agr., Agr. Res. Serv. Prod. Res. Rpt. 40, 33 pp. 1960.

Pratt fsl at Woodward, Okla., and Cheyenne fsl at Mandan, N. Dak., were studied in attempts to characterize the physical nature of plowpans that had developed in both soils and to ascertain the effects of the plowpan on plant growth. Investigations were conducted in the field, laboratory, and greenhouse.

The plowpan found in the Pratt soil hinders root penetration, reduces infiltration of water, and increases soil erosion, and because of these effects, reduces crop yields. The plowpan found in the soil at Mandan is not sufficiently severe to influence crop yields.

In field and laboratory studies on the Pratt soil, infiltration was definitely reduced by the plowpan. Related laboratory measurements indicated that there were only minor differences in percolation rate, pore space, mechanical analysis, moisture equivalent, and bulk density, among the surface 3 inches of soil, a 3-inch layer of soil between the surface of the soil and the plowpan, and a 3-inch layer of soil including the plowpan. It was indicated that the clay content changed with depth and that the percolation rate was inversely related to the clay content.

In studies on the Cheyenne soil at Mandan significant correlation was found between penetrometer readings and soil-moisture determinations when the bulk density was greater than 1.30 grams per cubic centimeter. Penetrometer readings and bulk-density measurements were also found to be significantly correlated. It was concluded that bulk density had a greater influence on penetrometer readings than did soil moisture over the moisture range studied. The effect of a single plowing operation on soil compaction could be detected when soil moisture conditions were favorable for compaction. Freezing and thawing over winter did not reduce the compactness of the plowpan layer, and there was no change in this plowpan layer during the summer.

On the Pratt soil at Woodward, penetration, bulk-density, and soil-moisture studies on spring shallow-plowed, fall deep-plowed, and alternately cropped and fallowed plots, showed the following: (1) The pressure required to penetrate the soil varied with the method of tillage as well as with the crop grown. The least pressure was required on the shallow-plowed soil; intermediate, on the deep-plowed soil; and greatest on the alternate cropped and fallowed soil (deep fall plowed in crop years). Significantly less pressure was required to penetrate the soil on the milo plots than that on the corn, broomcorn, kafir, and sorgo plots. (2) Bulk density of the soil varied with the method of tillage as well as with the crop grown. Bulk density of the spring shallow-plowed soil was least, intermediate, on the fall deep-plowed, and greatest on the alternately cropped and fallowed soil. Bulk density of the milo plots was significantly less than that of the corn, sorgo, broomcorn, and kafir plots. (3) There was a significant correlation between bulk density and penetration pressure; however, the low coefficient of determination (0.22) indicated that the relationship was not of great predictive value. Further study indicated that changes in soil texture between plowed and undisturbed soil were responsible for the low correlation. And (4) a study of the correlation between soil-moisture content and penetration pressure indicated that variations in soil-moisture content did not affect penetration-pressure date in this study.

Organic-matter and mechanical-analysis data collected on soil from the fall deep-plowed soil, the spring shallow-plowed, and from a sod profile nearby indicated the following: (1) That during 41 years of cropping approximately 50 percent of the original organic matter was lost on the shallow-plowed soil and 75 percent on the deep-plowed soil. (2) Organic matter was depleted to a greater depth on the deep-plowed plots. (3) Organic matter depletion took place below the depth of plowing on both plots. (4) There was no evidence of a concentration or depletion or organic matter in the plowpan as compared with that in the soil above or below it. (5) The soil below the depth of plowing on the shallow-plowed soil contained 114.8 percent more clay than that in the plowed layer; the comparable figure on the deep-plowed soil is 78.7 percent. (6) There did not appear to be a concentration of any particular-sized particles of soil in the plowpan. The particle size distribution in the plowpan was the same as that in the undisturbed soil beneath it. And (7) comparisons with the virgin sod profile indicated that the clay contents of the plowed zones had been depleted. It is not unreasonable to conclude that the clay was lost by wind erosion during the 41 years of cultivation.

Charts, tables, graphs, and photographs.

ARS, USDA, Inform. Div., Washington 25, D.C.

Lull, H. W. SOIL COMPACTION ON FOREST AND RANGE LANDS. U.S.D.A Misc. P. 768, 33 pp. 1959.

Soil compaction is a universal process associated with any use of forest or rangelands. Its major effect is to drastically reduce the pore space through which water moves into and through the soil, thereby reducing infiltration and percolation, increasing surface runoff, and encouraging erosion. These effects do not require heavy and repetitious travel. Under wet soil conditions normally encountered, even the lightest of vehicles or light-footed trampling can effectively compact the soil.

The present-day trend of intensive use of our forest and rangelands will undoubtedly involve not only more frequent travel but the use of heavier mechanized equipment. This could have serious effects not only on soils but also on streamflow, and perhaps, on site quality. At the same time, it is evident that considerable soil compaction has always occurred: our second- or third-growth forests provide evidence of considerable soil disturbance that occurred during past logging operations; and livestock trampling is not new - perhaps the greatest of trampling forces was the soil-pounding buffalo herds. Thus our forests and ranges have survived past soil compaction. Whether their present condition has been influenced by it is not known; nor can one predict the potential compaction from future more intensive use.

Soil compaction on forest and rangelands is a subject that merits intensive research. All phases of the subject beg for study; the compaction process; the extent of compaction in relation to forest and range harvesting methods; the effects of compaction on soils, erosion, surface runoff, streamflow, and site quality; and remedies for compaction and methods of preventing or minimizing it.

Inform. Div., FS, USDA, Washington 25, D.C.

Peters, D. B. RELATIVE MAGNITUDE OF EVAPORATION AND TRANSPIRATION. Agron. J. 52: 536-538. 1960.

The relative magnitude of soil evaporation and transpiration cannot be established as a precise ratio since the magnitude of each is dependent upon the relative wetness of the surface.

Evidence presented indicate that in the Midwest, where frequent summer showers occur, as much as 50% of the total water loss in a season can be accounted for by evaporation from the soil surface.

Plastic-covered plots have consistently yielded a value of from 5 to 9 inches of water use, regardless of location or year. It thus appears that the amount of transpiration from a particular crop is within rather narrow limits.

It has been established that in row crops sufficient energy reaches the ground surface to account for a considerable portion of the water loss. The absolute amount of water loss is, however, dependent upon the time the soil surface is wet and upon the moisture-holding and transmitting capacities of the soil. It would be virtually impossible to predict the absolute amount of soil evaporation.

SWCRD, ARS, USDA, Urbana, Ill.

Merriam, R. A. MOISTURE SAMPLING IN WILDLAND SOILS WITH A NEUTRON PROBE. Iowa State J. Sci. 34(4): 641-648. 1960.

The neutron probe provides soil scientists and others a research tool that can take its place with gravimetric sampling, electrical resistance techniques, and tensiometers as a "standard" method in soil moisture studies. Some advantages of this new technique are: (1) Sampling is limited only by the depth to which access tubes are installed. (2) Successive samples can be taken from the same point and additional samples at intermediate points may be made if desired. (3) One calibration curve suffices for a wide variety of soils. Further, readings are converted directly to soil moisture percent by volume so that variations in bulk density do not enter into determinations of equivalent depths of water for any soil depth. And (4) time required for soil moisture determinations with the neutron probe compares favorably with gravimetric and electrical resistance techniques. Resistance units require the greatest installation, calibration, and computation time, but may be read very rapidly when installed. Gravimetric sampling requires laboratory time for weighing, drying, and reweighing, besides time for field sampling and computation. Probe sampling requires about $2\frac{1}{2}$ minutes per sample plus a few minutes at each site to check the operation of the probe in the standard shield. Computation of soil moisture is most rapid with probe data.

Disadvantages of the neutron probe include radiation hazard unless recommended safety precautions are carefully followed. The original cost of the sampling equipment is high. Although the scaler and probe are well encased and completely portable, they are too heavy for one person to carry very far. Moisture measurements in the upper 12 inches of the soil may require a correction factor because of the escape of neutrons into the air. However, special probes for moisture determinations in this zone are available. In addition, both surface and depth density probes are available for determining the bulk density of soil in place.

Pacific Southwest Forest and Range Expt. Sta., FS, USDA, Glendora, Calif.

Peters, D. B., and Johnson, L. C. SOIL MOISTURE USE BY SOYBEANS. Agron. J. 52: 687-689. 1960.

To study the use of water by soybeans on a Brunizem soil in Illinois, three moisture treatments were imposed on soybean plots in 1958 and 1959. These were: (1) Open soil surface receiving natural rainfall; (2) plastic film-covered surface with no water added during growing season; and (3) plastic film-covered surface with 2 or 3 inches of water added by irrigation in 1-inch applications. In addition, the 1959 study included both 20- and 40-inch rows.

TABLE 1.--Water Economy of Soybeans for the Period July 2 to September 26, 1958, and Yields Obtained Under 3 Moisture Regimes

Treatment	Profile water use	Rain-fall rcvd.	Irriga-tion water	Total water use	Soybean yields	Efficiency of water use
	in.	in.	in.	in.	bu./acre	bu./in.
Open surface; natural rainfall	4.26	11.12	-	15.38	35.04	2.3
Covered; no water added	4.36	-	-	4.36	32.64	7.5
Covered; irrigated	3.10	-	2.00	5.10	34.73	6.8

TABLE 2.--Water Economy of Soybeans for the Period July 1 to September 20, 1959, and Yields Obtained Under 3 Surface-cover and 2 Row-width Treatments

Treatment		Profile water use	Rain-fall rcvd.	Irriga-tion water	Total water use	Soybean yields	Efficiency of water use
Surface cover	Row width						
	in.	in.	in.	in.	in.	bu./A.	bu./in.
Not covered; natural rainfall	20	5.71	5.61	0.0	11.32	22.5	1.98
	40	2.80	5.61	0.0	8.41	15.6	1.85
Covered; no water added	20	4.73	0.0	0.0	4.73	20.1	4.25
	40	3.76	0.0	0.0	3.76	18.2	4.84
Covered; irrigated	20	5.87	0.0	3.0	8.87	30.7	3.46
	40	2.17	0.0	3.0	5.17	28.8	5.57

The results obtained lead to the following conclusions: (1) Evaporation from the soil surface alone was responsible for half or more of the total moisture lost from the soil profile under a soybean crop when the soil surface was kept moist most of the season, and for one-fourth to one-half of the total moisture lost in a dry season. (2) Recharge of subsoil moisture is very important for maximum crop production. A considerable amount of water was used from the lower part of the soil profile even under irrigation, and summer rainfall affected only the upper half of the rooting zone. And (3) when frequent rainfall kept the soil surface moist, water loss from open-surface plots was nearly equal to open-pan evaporation for the growing season.

SWCRD, ARS, USDA, Urbana, Ill.

Finfrock, D. C., Raney, F. C., Miller, M. D., and Booher, L. J. WATER MANAGEMENT IN RICE PRODUCTION. L 131, folded. 1960.

Rice in California is grown under continuous flooding. The fields are flooded before planting by airplane and kept flooded until about 30 days before harvest. After the fields are drained, the remaining soil moisture is depleted sufficiently by the plants and evaporation to permit harvesting with combines.

Rice yields may be increased by giving careful attention to good water management, particularly to careful field preparation, adequate canals and drains, proper water-control devices, protection of the system from pests, and deliberate water manipulation during the growing season.

This is an instructional leaflet on developing the land for rice irrigation and water management during the growing season.

Calif. Agr. Expt. Sta. Ext. Serv. U. Calif., Berkeley, Calif.

Finnell, H. H. FACTORS AFFECTING MOISTURE-STORAGE EFFICIENCY OF DRYFARMING AREAS IN THE GREAT PLAINS. U. S. Dept. Agr., Agr. Res. Serv. Prod. Rpt. 37, 16 pp. 1960.

Certain naturally occurring and farm operational factors affecting moisture-storage efficiency during the interval between crops in 44 soil conservation districts under dryfarming conditions in the Great Plains during the crop years 1947-51 were evaluated. Records collected included total amount and character of rainfall; temperature; soil characteristics (texture, slope, color); previous crop; residues; weeds; length of period between crops; tillage; and other miscellaneous soil, crop, and climatic data.

Mean temperature variation had little effect on efficiency of moisture storage from southern South Dakota across Nebraska into northern Kansas. North of this area warmer temperatures generally increased moisture-storage efficiency. Temperature variation was one of the dominant factors related to moisture-storage efficiency in the southern Plains.

The effect of rainfall per week during the period between crops on moisture-storage efficiency was consistently negative. In only 9 districts out of 44 was the standard partial regression coefficient nonsignificant.

Average amount of precipitation per rainy day showed a significant negative relation to moisture-storage efficiency in 17 of 44 instances. In four cases the maximum precipitation per rainy day resulted in significant positive values.

Topsoil texture significantly affected moisture-storage efficiency. Moisture-storage efficiency was highest on sandy soils of the central and southern Plains. In the northern area, the high surface-soil content of organic matter of black and dark-brown soils was a dominant factor in moisture-storage efficiency.

Slope of the land was not one of the more important factors affecting moisture-storage efficiency, but what relationship that did exist was predominantly negative.

Among the several farming practices available to farmers to combat drought, water conservation practices provided better-than-average effects in the central area. Negative results were recorded in 2 of the southern districts, but 9 significant positive effects of water conservation were found.

Stubble mulching, as practiced by the average farmer, did not substantially affect moisture-storage efficiency. It usually was used as an erosion-preventing practice.

Volume of soil stirred in preparatory tillage operations did not statistically affect moisture-storage efficiency in 23 out of 44 districts.

Weed growth generally depressed moisture-storage efficiency, but only 13 districts showed a significant negative relationship.

Length of period between crops proved to be the most powerful and consistent factor studied in its effect on moisture-storage efficiency. Lengthening the preparatory period decreased moisture-storage efficiency to a highly significant extent in 41 out of 44 districts.

Moisture-storage efficiency can be influenced about as much by the operational factors selected by the farmers as by the natural variations in seasonal and soil conditions.

Tables.

ARS, USDA, Inform. Div., Washington 25, D. C.

Finnell, H. H. MOISTURE STORAGE AND CROP YIELDS IN THE DRY-FARMING AREAS OF THE GREAT PLAINS, AS AFFECTED BY NATURAL AND FARM OPERATIONAL FACTORS. U. S. Dept. Agr., Agr. Res. Serv. Prod. Res. Rpt. 39, 31 pp. 1960.

The effects of farm operational and naturally occurring factors on the accumulation of soil moisture during the idle period between crops and on crop yields in the dryland areas of the Great Plains, 1947-51 was studied.

Average coefficient of variation for all crop yields was 48 percent in the northern area, 70 percent in the central area, and 85 percent in the southern area. This, along with a reduction in general yield level (except for wheat) from north to south, indicates a generally more stable and favorable growing season climate in the north as compared to the south. Weed competition in the growing crop reduced yields without exception in the southern and central areas, the effect tapering off in the northern Plains. The effect of water conservation practices on yields was particularly strong in the south but noticeably declined northward. Except for oats, initial soil moisture storage favorably affected yields in the central area.

Moisture accumulation was generally enhanced by improved moisture-storage efficiency, by increased preparatory period rainfall per week and by more intense water conservation measures, and was generally reduced by weed growth during preparation. Darker topsoil color in the northern area and lower temperature during preparation and coarser soil texture in the central area resulted in improved soil moisture storage.

Tables and Maps.

ARS, USDA, Inform. Div., Washington 25, D. C.

Doss, B. D., Ashley, D. A., and Bennett, O. L. EFFECT OF SOIL MOISTURE REGIME ON ROOT DISTRIBUTION OF WARM SEASON FORAGE SPECIES. Agron. J. 52: 569-572. 1960.

The effect of three soil-moisture regimes on root distribution of dallisgrass, sericea, bahiagrass, Coastal bermudagrass, and common bermudagrass was determined on a Greenville fsl. Root distribution was characterized by obtaining 3-inch core samples, soil profile samples, and soil-moisture extraction patterns. In general, all three methods indicated a decrease in rooting depth as soil moisture increased. Both the total amount of roots and the rooting depths varied considerably with the various forage species and soil moisture regimes. Rooting depths for sericea and dallisgrass at all soil moisture regimes were considerably less than for the other species. Common and Coastal bermudagrasses had the greatest rooting depth at all soil moisture regimes. Bahiagrass rooting depth was slightly less than for the bermudagrasses.

Root concentration of all species decreased with increasing depth, with approximately 50% of the roots being in the upper 3 inches and 76% in the upper foot of soil.

Wide differences were found in total root weight among the different species. Bahiagrass had two or more times the total amount of roots than any other species except common and Coastal bermudagrass.

SWCRD, ARS, USDA, Thorsby, Ala.

Koshi, P. T. SOIL-MOISTURE TRENDS UNDER VARYING DENSITIES OF OAK OVERSTORY. Southern Forest Expt. Sta. Occas. Paper 167, 12 pp. 1959.

From May 1953 to August 1954, a study was made of soil-moisture trends under undisturbed, thinned, and cleared post oak stands on Susquehanna-like soils in Texas.

Throughout most of the test, the moisture content of the upper two feet of the soil profile was highest in the cleared, intermediate in the thinned, and lowest in the undisturbed areas. Most of the difference occurred in the 12- to 24-inch horizon.

Roots of grasses were active chiefly in the upper 12 inches of the soil profile, while the tree roots also withdrew water consistently from the 12- to 24-inch horizon.

Moisture content at 15.0 atmospheres pressure was not an accurate index of wilting point, since rapid depletion continued to considerably lower levels.

Either grass or tree vegetation is capable of withdrawing all available moisture from the entire upper 24 inches of the soil profile. Trees withdrew water from upper and lower horizons simultaneously; grasses tended to exhaust the upper horizons before making substantial withdrawals from the 12- to 24-inch levels.

Maximum daily depletion rates occurred during the growing season and were in the magnitude of 0.2 inch for both grass and tree vegetation. In winter, the wooded plots lost moisture at rates of 0.04 to 0.05 inch daily, in contrast to 0.01 to 0.02 inch for the cleared plots.

The number and duration of periods of moisture stress, during which little or no moisture was available in the upper 24 inches of soil, were reduced by thinning and clearing.

The essentially saturated condition of the soils on the cleared plots throughout the winter season may have limited root development in the 12- to 24-inch level by reducing soil aeration. The saturated soils of the clearcut plots afforded less opportunity for storage of excessive rainfall, and thereby offered less check to runoff and flooding.

Southern Forest Expt. Sta., FS, USDA, New Orleans, La.

Weaver, H. A., and Speir, W. H. APPLYING BASIC SOIL WATER DATA TO WATER CONTROL PROBLEMS IN EVERGLADES PEATY MUCK. U. S. Dept. Agr., Agr. Res. Serv. ARS 41-40, 15 pp. 1960.

Basic physical data for Everglades peaty muck including moisture tension relationships and saturated hydraulic conductivities have been examined for their applicability to solution of water control problems.

The equilibrium air contents above stationary water tables were computed, and the complications affecting their value in estimating storage capacity and drainage water release discussed.

The use of drainage rates to estimate required water table drawdown time was evaluated. Water release data divided by instantaneous drainage rates determined through use of the Hooghoudt and the Ernst-Boumans solutions for successive steady state water tables gave a measure of time required for the water surface to pass through small layers above closed drains. Similarly, the drawdown times for ditches were estimated from an adaptation of Colding's ellipse formula.

The application of Glover's nonsteady-state formula yielded drawdown times considerably less than those obtained by other methods for closed drains.

Overall results indicated that underdrain spacings at a 30-inch depth should not exceed about 40 feet, and ditches penetrating to the impermeable layer should not exceed 60 feet where either system must be depended upon to lower water tables to safe depths within 48 hours after profile saturation.

ARS, USDA, Inform. Div., Washington 25, D. C.

Keller, W. D. ACIDITY-ALKALINITY OF SURFACE DRAINAGE WATERS AS RELATED TO UNDERLYING SILICATE ROCKS. J. Sedimentary Petrology 30: 582-584. 1960.

Surface drainage waters in humid regions underlain by silicate rocks range in pH from about two units above to several units below neutrality. Alkaline waters were observed in regions underlain by pyroclastic rocks and nepheline syenite, whereas acid surface waters were measured where the underlying rocks were gneisses, granites, and certain other igneous rocks. The pH of the surface water is interpreted as being influenced by the hydrolytic (alteration) products of the rocks--the more alkaline water being associated with the silicate rocks most susceptible to hydrolysis.

U. Mo., Columbia, Mo.

Lime

Woodle, H. A., and Turner, E. C. AGRICULTURAL LIMESTONE. Clemson Agr. Col. C. 459, 15 pp. 1959.

South Carolina soils in general are naturally strongly acid. On the basis of results secured from more than two million soil tests made by the Clemson College Soil Testing Laboratory during the past 25 years, it is estimated that South Carolina farmers need to apply about 1,600,000 tons on liming materials annually. At present, farmers are using less than 200,000 tons of liming materials annually. Crop quality and yields are both lowered when insufficient amounts of liming materials are used.

Agricultural liming materials should be applied to South Carolina soils in amounts sufficient to raise the pH value of the soils to that which is most favorable for the crops grown. Agricultural limestone (both calcium and calcium-magnesium) and basic slag are the liming materials generally recommended and used in South Carolina. Farmers should select their agricultural liming materials on the basis of price, acid neutralizing ability, and composition. Fertilizers and liming materials containing magnesium should be used when soils are deficient in magnesium, or for crops with high magnesium requirements.

Charts, tables, and graphs.

Clemson Agr. Col. Ext. Serv., Clemson, S. C.

Shaw, W. M. RATE OF REACTION OF LIMESTONE WITH SOILS. Tenn. Agr. Expt. Sta. B. 319, 23 pp. 1960.

The rate of reaction of ground limestone with certain Tennessee soils was studied. Field lysimeters were employed as reaction containers for the outdoor experiments; supplementary greenhouse and laboratory experiments were conducted to study the effects of temperature and moisture variations on the limestone-soil reaction. The limestone-soil reactivity was gauged principally by the residual carbonate method and to some extent by the determination of pH values at certain intervals.

In lysimeter experiments (1947-1951) calcitic limestone particles passing a 60-mesh sieve dissolved in 1 year when the rate of application approximated the exchange acidity of the soil. The 1-year results are twice as high as those found in Ohio. A 35-mesh particle size of calcite required about 2 years for complete dissolution; and 18-mesh particle, 3 to 4 years.

For dolomitic limestone to be equal in effectiveness to calcitic limestone, it must be ground twice as fine. The relative efficiencies of the two types of limestone, however, will depend upon the stage of dissolution at which the comparison is being made. The shorter the period of reaction the smaller will be the relative dissolution of the slower reacting material. When the calcitic material had run its full course, the dolmite of equal fineness had reached 75 to 85 percent dissolution.

The carbonate dissolution in the 6-month greenhouse experiment with growing alfalfa showed a somewhat slower rate of reaction of calcite that was indicated in the lysimeter study. The slower reactivity may be attributed to a lower moisture content of the limestone-soil mixture in the greenhouse.

Reactions between calcite particles and a Hartsells soil were conducted at 50° , 68° , and 86° F. At 50° F. the 35-mesh particles dissolved at the rate of 2,000 lbs. per acre in 30 days, whereas at 86° F. these particles dissolved at the rate of 6,400 lbs. per acre. For finer particles the differences in dissolution rate at the two temperatures narrowed, but for particles of intermediate size the dissolution ratios were about 1 to 3 for the 50° and 86° F. temperatures. The increased rate of diffusion of the calcium bicarbonate molecules is considered partly responsible for the greater reactivity at the higher temperature.

The results with different-sized particles of calcite have shown that limestone-soil reaction is speeded up by increasing the soil moisture level from 50 to 100 percent saturation. The 60-day dissolutions of 35-mesh calcite with Cumberland subsoil at moisture saturations of 60, 80, and 100 percent were 44, 60, and 72 percent of the application.

Very fine calcite particles (120-mesh) made good reaction progress at low moisture levels, as shown by the 14-day results. However, in 7 days, the fine particles also show increased solution with increased moisture.

According to present findings, calcitic limestone particles passing a 60-mesh sieve may be expected to completely react with the soil in the first year; those passing a 40-mesh sieve, in 2 years. The coarser particles may be expected to show 1-year efficiencies of 93, 81, 85, 33, and 18 percent for particles of 40, 30, 20, 10, and 8-mesh. The 1-year efficiencies of 60, 40, 30, 20, and 10-mesh dolomite are estimated as 87, 66, 51, 39, 17, and 10 percent.

U. Tenn., Agr. Expt. Sta., Knoxville, Tenn.

Barnes, E. E., Lamb, C. A., and Volk, G. W. EFFECT OF LIME LEVEL AND SOIL pH ON SELECTED CROPS AND THEIR RESPONSES TO PHOSPHATE AND MANURE. Ohio Agr. Expt. Sta. Res. B. 862, 27 pp. 1960.

The Legume-reaction Experiment was designed to answer a number of questions concerning soil reaction and fertility conditions which enable crops to make maximum yields. The land used was systematically tiled and limed to bring the ranges to the desired reactions in 1928.

Soil Reaction: The experimental area was divided into five ranges. An attempt was made to adjust the different ranges to different reactions by ammonium sulfate or lime to a soil that was originally a pH of 5.2. The objective for Range I to Range V was a pH of 4.5, pH 5.0, pH 6.0, pH 7.0, and pH 8.0, respectively. The reaction of Range V never reached pH 8.0 on all the plots but in the course of 3 or 4 years most were above pH 7.5.

The rotations grown do not indicate satisfactory performance at soil reaction below pH 6.0. Soybeans for hay, and oats for grain showed the greatest tolerance for acid soils; barley for grain showed the least. Of the forage legumes, mammoth clover ranked consistently high at low soil reactions. Of the legumes, alfalfa and sweetclover were most seriously affected by low pH. Except for barley, the grain crops apparently reached maximum production at about pH 7.0, and the higher soil reaction tended to depress the yields. The ideal range would appear to be pH 6.5 to pH 7.0 for these crops.

Phosphate was needed on this soil. Response of wheat to phosphate was greatest of the grain crops, being about 18 bushels per acre at pH 4.5, pH 5.0, and pH 6.0. At pH 7.0 to 7.5 response from phosphate decreased but was still considerable. Oats also showed good returns for added phosphorus, but maximum response was at pH 6.0; yield increases were much less as the soil became more acid or approached neutrality. Apparently phosphorus in the soil becomes more readily available as the soil pH increases with the result that the fertilizer has less apparent effect. With time this effect would likely decrease, since the phosphorus made available on this soil by liming might be exhausted after a few years. Barley followed the same general response pattern as oats, modified by the extreme sensitivity of the crop to soil acidity. Corn actually showed yield decreases for applications of phosphorus on Ranges I and V, and very minor response at the intermediate soil reaction. Hay crops responded to phosphorus only at pH 6.0 and above, and response decreased above neutrality.

When a moderate application of phosphate was used, and 8 tons of manure added each 3 years on half of the plots, corn gave consistently good response to the manure with a maximum at pH 6.5. In contrast, wheat yields were increased rather uniformly across all soil reactions. Oats gave a somewhat better response to manure on the more acid soils, probably because of the poorer legume growth on these ranges and the smaller amount of nitrogen available. Barley responded well with greatest increase at high soil pH. This probably resulted from the poor performance of the crop on acid soils. Hay responded well to manure at all soil reactions. Maximum response was obtained at pH 6.5 to pH 7.0.

Ohio Agr. Expt. Sta., Wooster, Ohio.

Moschler, W. W., Jones, G. D., and Thomas, G. W. LIME AND SOIL ACIDITY EFFECTS ON ALFALFA GROWTH IN A RED-YELLOW PODZOLIC SOIL. Soil Sci. Soc. Amer. Proc. 24: 507-509. 1960.

Rates of ground dolomitic and calcitic limestone ranging from 0 through 16 tons per acre were applied to Tatum sil at the time of seeding alfalfa in the spring of 1956. Lime proved to be indispensable to yield and longevity. Total yields for three cutting years ranged from 0.25 to 8.0 tons per acre and stand survival at the end of the third cutting year varied from 0 to 95%. A true "critical level" of calcium or magnesium in neither soil nor plant was found. Rather, increases in the rate of lime applied were accompanied by gradual increases in soil pH, exchangeable bases, and percentage base saturation. In contrast, the application of relatively small amounts of lime reduced the exchangeable aluminum content of the soil sharply, and these reductions were closely correlated with increased alfalfa yields. Yields were in better agreement with base-exchange saturation calculated from exchangeable metal cations than that calculated from metal cations plus exchangeable hydrogen. A slight and consistent increase in yield from dolomitic stone over calcitic stone was not significant. Decrease in exchangeable aluminum in the soil and improved nitrogen metabolism are postulated as the chief favorable factors under the conditions of this experiment.

Va. Polytech. Inst., Blacksburg, Va.

Soil Chemistry

Carter, J. N., and Allison, F. E. INVESTIGATIONS ON DENITRIFICATION IN WELL-AERATED SOILS. Soil Sci. 90: 173-177. 1960.

Denitrification studies with three soils, (Branchville sl, Fayetteville sil, and Crosby sil) kept well-aerated under laboratory conditions and variously treated, are reported. The extent of loss of nitrogen was determined by the differences in total nitrogen and excess N-15 nitrogen before and after incubation.

Very little nitrogen loss occurred under aerobic conditions except where dextrose was added in the presence of nitrates. The losses of N-15 nitrogen under these conditions commonly varied between zero and 12 percent; wheat straw produced no significant losses. Additions of $CaCO_3$ also had no significant effect on nitrogen losses.

It was concluded that denitrification is of minor importance in soils that are kept strictly aerobic, but under field conditions this ideal condition may not exist at all times even in the more open soils. The gaseous losses of nitrogen that do occur under will-aerated soil conditions may be attributed chiefly to processes other than denitrification.

SWCRD, ARS, USDA, Beltsville, Md.

Axley, J. G., and Legg, J. O. AMMONIUM FIXATION IN SOILS AND THE INFLUENCE OF POTASSIUM ON NITROGEN AVAILABILITY FROM NITRATE AND AMMONIUM SOURCES. Soil Sci. 90: 151-156. 1960.

A wide range in ammonium fixation capacities was exhibited by representative Maryland soil profiles. The availability of ammonium added to some of the soils was determined by nitrification and plant uptake studies. Nitrification of added ammonium ranged from 57.1 to 9.6 percent for soils with low- to high-fixation capacities, respectively, as compared to 94.4 percent for a non-fixing surface soil used as a control. Plant uptake of nitrogen from $(NH_4)_2SO_4$ or urea was not greatly affected by the capacity of the soil to fix ammonium unless sufficient potassium was present to block the release of ammonium. Additions of potassium with $NaNO_3$ had little effect on yields or nitrogen uptake, but with an ammonium source of nitrogen, similar potassium treatments severely decreased yields and nitrogen uptake from soils having appreciable fixation capacities. The data suggests that a nitrate source of nitrogen should be used when nitrogen and potassium are applied simultaneously to soils capable of fixing ammonium.

U. Md., College Park, Md.

Synghal, K. N. A SIMPLER AND MORE ACCURATE PROCEDURE THAN IOWA METHOD FOR DETERMINING NITRIFICATION IN SOILS. J. Indian Soc. Soil Sci. 8: 219-222. 1960.

A simple procedure to study the nitrifying powers of soils has been devised by Fitts et al. (1955) at Iowa State College. This method was developed while stydying the relationship of nitrification to nitrogen fertilization in Iowa soils. During the present study, an attempt was made to use the Iowa method on four Alberta soils. Since results obtained by this method were not consistent, an alternate procedure which is simpler and more accurate was adopted and is described in this paper.

The advantages of the proposed system over the Iowa system are: (1) A larger quantity of soil sample is used which is likely to be more representative than the smaller quantity used in Iowa method; (2) the necessity of having suction arrangements is eliminated; (3) the steps of extracting and clarifying the extract are achieved in one operation; and (4) it is simple, rapid, and accurate.

Regional Res. Cent., Patiala, Punjab, India.

Franklin, W. T., and Reisenauer, H. M. CHEMICAL CHARACTERISTICS OF SOILS RELATED TO PHOSPHORUS FIXATION AND AVAILABILITY. Soil Sci. 90: 192-200. 1960.

The soil properties associated with P fixation and availability were determined by statistically relating several of the chemical and mineralogical characteristics of soils, including type and content of clay, cation-exchange properties, and measures of the different soil P fractions and P sorption and availability. These determinations were made on 17 widely diverse Washington soils.

Phosphate sorption was highly correlated with the exchangeable Al and citric-acid-soluble Al contents of the soils, but was not related to either the type or content of clay. Citric-acid-soluble Al was 160 times more active in P sorption than was citric-acid-soluble Fe.

The availability of soil P measured by an A-value technique and chemical extractants was directly related to the "inorganically combined P/citric-acid-extractable Al" ratio. Over 80 percent of the variation in available P of these soils was accounted for by regression on this ratio.

Residual effects of phosphate fertilization observed in the field were much greater than the effect predicted from the resultant shift in the soil's P/Al ratio. This suggests that the nonequilibrium P compounds of relatively high availability that are formed from added phosphate fertilizers may persist for several years in soils of high P-sorption capacities.

Sci. Papers 1870, Wash. Agr. Expt. Sta., Pullman, Wash.

Yuan, T. L., Robertson, W. K., and Neller, J. R. FORMS OF NEWLY FIXED PHOSPHORUS IN THREE ACID SANDY SOILS. Soil Sci. Soc. Amer. Pro. 24: 447-449. 1960.

Soils were extracted successively with $1\underline{N}$ NH_4Cl, $0.5\underline{N}$ NH_4F, $0.1\underline{N}$ NaOH, and $0.5\underline{N}$ H_2SO_4 solutions to represent water-soluble, aluminum, iron, and calcium phosphates, respectively. Over 80% of the added phosphorus was retained by the soils as aluminum and iron phosphates. Less than 10% was in the water-soluble and calcium phosphate forms. The balance not accounted for may have been in forms other than those mentioned.

The ratio of aluminum phosphates to iron phosphates increased with the rates of applied phosphorus for the three soils. This was more evident for Red Bay fsl and Norfolk lfs than Leon fs.

Increasing soil drying temperature decreased the percentage of phosphorus in the aluminum phosphate form, but increased that in the iron phosphate form. The prolonged alternate wetting and drying reduced the percentage of phosphorus in aluminum form in Red Bay fsl and Norfolk lfs, and increased the percentage distribution in iron form in Red Bay fsl and Leon fs.

Fla. Agr. Expt. Sta., Gainesville, Fla.

Toth, S. J., and Alderfer, R. B. FORMATION AND BREAKDOWN OF Co60-TAGGED WATER-STABLE SOIL AGGREGATES IN A NORTON SILT LOAM SOIL. Soil Sci. 90: 232-238. 1960.

A technique for studying the formation and breakdown of water-stable soil aggregates tagged with Co-60 was used in an incubation and greenhouse study employing aggregates isolated from a Norton sil soil. The most important findings were: (1) The physical composition of water-stable soil aggregates is constantly changing; (2) during incubation the contribution of small-sized tagged aggregates to the formation of larger ones decreased as the size of the tagged aggregates was reduced; (3) aggregates of all size ranges examined contained fragments of the original tagged aggregates; and (4) under bluegrass sod, the contribution of the tagged aggregates of small-size ranges to the formation of larger ones was greater than that noted under incubation.

N. J. Agr. Expt. Sta., Rutgers State U., New Brunswick, N. J.

Hammes, J. K., and Berger, K. C. MANGANESE DEFICIENCY IN OATS AND CORRELATION OF PLANT MANGANESE WITH VARIOUS SOIL TESTS. Soil Sci. 90: 239-244. 1960.

Available soil Mn, extracted by four chemical methods, was correlated with Mn contents of oats. The soils were neutral to alkaline in reaction, and were developed on alkaline, lacustrine parent material. Extraction of air-dry samples resulted in much higher correlation coefficients than did extraction of moist samples.

Results indicate than Mn deficiency on oats can be expected when the soil Mn extracted with EDTA is less than 50 p.p.m., or when the soil Mn extracted with hydroquinone is less than 65 p.p.m., or when the soil Mn extracted with either H_3PO_4 or $NH_4H_2PO_4$ is less than 20 p.p.m. From the results, the H_3PO_4 extraction appears to be the method that is most reliable and easiest to use.

Young oats containing less than 30 p.p.m. Mn are likely to be deficient, whereas mature grain having an Mn concentration of less than 12 p.p.m. would be regarded as deficient.

Correction of Mn deficiency on oats can be effected by a single foliar spray application of Mn sulfate. Mn sulfate applied at the acre rate of 5 lbs. in 15 gallons of water proved very effective. Correction of Mn deficiency on oats was also accomplished by soil fertilization with Mn sulfate in conjunction with a carrier fertilizer. Twenty-five pounds per acre of $MnSO_4$ mixed with 250 lbs. of

4-16-16 and drilled with the seed was effective for the correction of Mn-deficiency on neutral and alkaline soils. Broadcast application of Mn sulfate was not satisfactory for the correction of Mn deficiency on oats.

U. Wisc., Madison, Wisc.

Hanway, J. J., Handy, R. L., and Scott, A. D. EXCHANGEABLE POTASSIUM CLAY MINERALS IN SELECTED IOWA SOIL PROFILES. Iowa Acad. Sci. 67: 215-231. 1960.

Exchangeable K values and X-ray diffraction patterns were obtained for soil samples from several modal profiles of nine different soil series in Iowa. Exchangeable K in "moist" subsoils was consistently low and almost always lower than in the "moist" surface soil. Drying increased exchangeable K in all the soils, but the increase due to drying varied between soil series and with depth in the profile of each series. Reversion of exchangeable K to a non-exchangeable form on rewetting the ovendry samples generally increased with depth in the profile but the exchangeable K never decreased to the original "moist" level. X-ray diffraction analyses showed the presence of montmorillonite, chorlite, illite and/or mica, and kaolinite in all the profiles, with montmorillonite predominating. Vermiculite was present in some of the soil series. No relationship between the clay mineral content and the amount of exchangeable K could be established.

Iowa Agr. and Home Econ. Expt. Sta., Ames, Iowa.

Dakshinamurti, C. STUDIES ON THE CONDUCTIVITY OF CLAY SYSTEMS. Soil Sci. 90: 302-305. 1960.

The ratio of the conductivity of an electrolyte, calcium chloride or potassium bromide (ca), and that of a clay system in equilibrium with it (cg) were determined for bentonite, Rothamsted subsoil clay, Swedish clay No. 1 and No. 2, and kaolinite. At each concentration of the electrolyte studied, the percentage weight of the clay could be varied up to about 18 percent. At any one concentration of the electrolyte studied, the relative conductivity values were found to vary linearly with the percentage weight of the clay. At the critical electrolyte concentration characteristic for each clay, the relative conductivity value worked out to be unity and was found to be independent of the percentage weight of the clay present in the system. The critical concentration, also called the isoconductivity value, for the clay was found to be a linear function of the cationic exchange capacity of the clay, and its determination seems to offer a method for the estimation of the cation-exchange capacity of the clay. The results further suggest that the clay electrolyte system might be considered as consisting of concentrated groups of opposite charges, which, at and above the critical concentration for a clay studied, would form the gel structure and immobilize the fluid. Since clay particles with a greater cation-exchange capacity value would repel each other with a greater force, to immobilize them a higher critical electrolyte concentration was found to be necessary.

Indian Agr. Res. Inst., New Delhi, India.

Soil Physics

Longenecker, D. E. INFLUENCE OF SOLUBLE ANIONS ON SOME PHYSICAL AND PHYSICO-CHEMICAL PROPERTIES OF SOILS. Soil Sci. 90: 185-191. 1960.

Preliminary investigations into the possible influence of soluble anions upon phenomena associated with changes in soil physical properties are reported. Data are presented to show the effect of soluble anions on the breaking strength of artificial soil crusts, flocculation volumes of clay suspensions, cation-exchange equilibria, and viscosity of clay suspensions.

Results of these studies indicate that there is a specific soluble anion effect, and that this effect may be of possible significance under conditions where soluble salts are present in appreciable quantities.

A considerable variation was noted between the effect of soluble sulfate and soluble chloride in all phases of the study. The nitrate ion appeared to behave very much like chloride in all properties investigated.

The effect of soluble anions upon cation-exchange equilibria may be of particular significance. This study indicates that all soluble ions, rather than cations alone, should be considered in exchange equilibria investigations.

Tex. Agr. Expt. Sta., College Station, Tex.

Haythornthwaite, R. M. MECHANICS OF THE TRIAXIAL TEST FOR SOILS. J. Soil Mechanics and Found. Div., ASCE 86(SM 5): 35-62. 1960.

The triaxial test is analyzed against the background of plastic theory. It is shown that the equilibrium conditions and a failure criterion such as Coulomb's law are insufficient to define a unique failure load; a stress-strain relationship is also needed. The problem is then solved completely for an ideally plastic material. The results are used to discuss the significance of test data for sands and an alternative yield criterion is suggested on the basis of the test data.

U. Mich., Ann Arbor, Mich.

van't Woudt, B. D. PARTICLE COATINGS AFFECTING THE WETTABILITY OF SOILS. J. Geophysical Res. 64(2): 263-267. 1959.

The fundamental principles underlying the process of wetting show that a reduction in the surface tension of a solid substance to be wetted reduces the wettability. Conversely, a reduction in the surface tension of the applied liquid increases the wettability. The wetting of a soil, which exhibits water-repellency in an air-dry state, can sometimes be achieved by leaving water in contact with this soil. There is some evidence that this wetting is achieved by an interaction of the solid and the liquid phase, leading to a reduction in the surface tension of the liquid. The phenomenon of advancing and receding angle of contact had led to an hypothesis that the angle of contact changes as the soil wets up or dries out. Some evidence is presented which does not support such an assumption, as the angle of contact seems fixed at a moisture content just above air-dry. There is some evidence that under certain conditions an improvement in the base status of the soil may lead to improved wettability. Particle coatings by hydrophobic films are in some cases responsible for the observed water-repellency. There is some evidence that this film is strongly absorbed. No quantitative relationship could be detected between the characteristics of substances extracted by chloroform from a problem soil and the degree of unwettability of such a soil.

U. Hawaii, Honolulu, Hawaii.

Soil Biology

Booth, E. NITROGEN REQUIREMENTS: SOIL ORGANISMS MUST HAVE ORGANIC MATERIAL. Grower 54(4): 256. Aug. 6, 1960.

The chemical industry now produces inorganic compounds containing ammonium salts, nitrites, and nitrates, as well as the organic compound urea. The simple process of trial and error has shown that most plants can obtain some of their nitrogen from any one of these chemicals. It is not generally realized, however, that all the fertilizers and dung, etc., only account for about half the nitrogen removed by the crops and that half must, therefore, be supplied by organic nitrogen in the soil--either by biological fixation or from the atmosphere.

Plants appear to be able to utilize nitrogen in almost any form. It may be claimed that the inorganic compounds are quicker acting than organic nitrogen, but some organic nitrogen sources--such as urea or dried blood--are also recommended and used as quick-acting fertilizers.

The plant physiologist, however, has not yet clarified the manner in which plants take in nitrogen from the soil; it is generally assumed that they can only absorb small molecules or ions, such as nitrate or ammonium, but this is an over-simplification.

Study of algae and bacteria in culture (which is a convenient way for the plant physiologist to work with simple organisms in a less complex medium than soil) has, so far, added to our knowledge, but it has shown that nitrites enhance nitrogen uptake.

The essential point is that the plant, by some unknown method, can utilize nitrogen in almost any form. An average soil analysis will indicate about 0.2 to 0.4 percent organic nitrogen and nitrate nitrogen may vary from about 10 p.p.m. to rather more than 100 p.p.m. in exceptional cases. This is equivalent to two to four tons of organic nitrogen per acre of top soil or 5 to 50 lbs. of nitrogen in the nitrate form. Thus, it is reasonable to assume that the organic nitrogen in the soil can play a substantial role in the nitrogen nutrition of the plant.

The problem of soil nitrogen is further complicated by the fact that soil samples, unless dried or frozen, can double their inorganic nitrogen content in almost four weeks. It has been suggested that this is due to the action of soil bacteria or fungi, but it is not known where the nitrogen comes from; it could only be obtained either from the atmosphere or from organic nitrogen in the soil.

The latter is the more generally accepted source of soil nitrogen and soil organisms which utilize organic nitrogen and excrete inorganic nitrogen are known.

It can be stated that, on the average, about half the nitrogen requirements of our crops are derived from fertilizers and manure added to the soil and a similar amount is derived naturally by the plant from its surroundings.

Sufficient evidence is now available on the various mechanisms by which the plant obtains nitrogen to suggest that no fertilizer program is adequate unless organic material is also used to support the growth of soil organisms.

Inst. Seaweed Res., Inveresk, Midlothian, Scotland.

Mulder, E. G., and Veen, W. L. van. EFFECT OF pH AND ORGANIC COMPOUNDS ON NITROGEN FIXATION BY RED CLOVER. Plant and Soil 12: 91-113. 1960.

The observed beneficial effect of added calcium carbonate and of some organic compounds on symbiotic nitrogen fixation by red clover, growing on acid soil is explained. The investigations started in 1957 when mixtures of grass and red clover were sown on a series of plots of varying pH. The growth of the clover appeared to be luxurious at pH 6.6 but extremely poor at pH values of 5.0 and lower. The latter was due to the absence of root nodules.

On some acid plots which had been treated with stable manure a few years before starting the clover experiments, the red clover was well nodulated and an excellent growth was made, notwithstanding the pH of the soil was somewhat lower than that of untreated plots, where the clover suffered from severe nitrogen deficiency.

The authors summarized this work as follows:

1. Red clover grown on acid soil under field conditions and in pot experiments was found to be poorly nodulated or to lack nodules. The plants suffered severely from nitrogen deficiency and gave low yields.
2. Inoculation of the acid soils with a suspension of an effective strain of Rhizobium trifolii gave well-nodulated plants which grew vigorously. More than 60,000 Rhizobium cells had to be introduced into 500 g soil to attain a normal nodulation.
3. Calcium carbonate added to the acid soils in amounts of one or two grams per 500 g of soil brought about, after a retardation of approximately four weeks, a normal nodulation of the clover plants. Since precautions had been taken that no foreign Rhizobium cells were introduced into the soil after neutralization, it was assumed that the bacteria had been originally present in the acid soil in low numbers.

By counting the numbers of effective Rhizobium cells, it was found that neutralization of the acid soil without planting of red clover had no effect on the multiplication of the bacteria. In the presence of red clover plants, however, an enormous rise in Rhizobium trifolii was found to occur in neutralized acid soil but not in acid soil. This demonstrates that inability of the bacteria to grow and spread in the rhizosphere presumably is responsible for the poor nodulation of the clover plants on acid soils.

4. Treatment of acid soils with yeast extract or a sterilized suspension of effective or ineffective Rhizobium trifolii promoted nodulation of red clover growing on these soils. This effect was less regular than that of added calcium carbonate. Stable manure and stable-manure extract in some cases reacted similarly. So far the substance responsible for the stimulative effect has not been found.

Lab. Microbiology, Agr. U., Wageningen, the Netherlands.

Rybalkina, A. V., and Kononenko, Y. V. THE MICROFLORA OF DECOMPOSING PLANT RESIDUE. Soviet Soil Sci. 5: 537-549. May 1959.

Experiments on the microflora which brought about the decomposition of plant residues were conducted under laboratory conditions. The following plant residues were taken from saline solenetz soils: (1) A mixture of cultivated grasses--lesparto, brome grass, and a perennial steppe grass; (2) plant residues of a virgin soil steppe composed primarily of wormwood and a small quantity of Agnus castus; and (3) certain species of saltwort on solonchak from the Shala-Kupa Lake.

The authors made the following conclusions:

1. The decomposition of plant residues is produced by an intricate complex of various microorganisms, the composition of which changes during the decomposition process.
2. Non-spore-forming bacteria which form a large amount of slimy capsules, as well as the yeasts, fungi, and amoebae play a dominant role in the early period of decomposition. Later it is the spore-forming bacteria and actinomycetes that play the dominant role.
3. The complexes of microorganisms which decompose the plant residues of the grass mixture and virgin steppe, are similar in themselves, but differ sharply from those in the saltworts. This is determined obviously by the chemical composition of this type of plant.
4. The microflora of decomposing plant residues differs from that of the soil by the sharp increase in the number of microorganisms and by the change in their species composition.
5. The processes which occur during the decomposition of the plant residues have an effect on the soil under the residues by changing the quantity and species composition of its microflora. These changes, however, are of short duration and take place only in that period when the decomposition of the plant residues occurs. The microflora remains similar to that of the soil in the residues of the different variants that have been humified.

Amer. Inst. Biol. Sci., 2000 P St. N. W., Washington 6, D. C.

EROSION CONTROL

Wind and Water Erosion

Food and Agriculture Organization of the United Nations. SOIL EROSION BY WIND AND MEASURES FOR ITS CONTROL ON AGRICULTURAL LANDS. FAO Agr. Develop. Paper 71, 88 pp. 1960.

Major areas of occurrence and damages caused by wind erosion of soils are briefly described in the study as an indication of the scope and serious nature of the problem in many agricultural areas. The process of soil erosion, its effect on the soil, and the dominant soil and land surface conditions relating to soil erodibility are discussed in some detail, since they are the basis for control measures.

The chapter entitled "Wind erosion control measures" describes those which have been successfully developed in North America, Australia, and elsewhere. Particular attention is devoted to the part that improved tillage and cultural practices play in control of soil erosion by wind in dry-farming areas. Emphasis is also given to special problems, including dune and drift stabilization, emergency measures to stop wind erosion once it begins on cultivated lands, and control on grazing lands.

The problem of soil erosion by wind in lesser developed countries, particularly in the semiarid tropics, is treated in some detail. Experiences in other agricultural areas and interpretation of basic information available on the subject are used as a basis for recommending measures for control of soil erosion by wind in these countries.

A sizeable list of selected references is included.

$1.00 from Columbia U. Press, International Doc. Serv., 2960 Broadway, New York, N.Y.

Lyles, L., and Woodruff, N. P. ABRASIVE ACTION OF WINDBLOWN SOIL ON PLANT SEEDLINGS. Agron. J. 52: 533-536. 1960.

El Reno sideoats grama, Blackwell switchgrass, sand lovegrass, Indiangrass, and Buffalo alfalfa seedlings were exposed to blowing soil carried by 7 different wind velocities between 20 and 31 miles per hour in a wind tunnel. Measurements of damage were made by visual inspection and by weighing the plant material 1 to 2 months after exposure.

Average maximum reductions in yield of plant material for 2 years data were 18% for sideoats grama, 40% for switchgrass, 37% for sand lovegrass, 35% for Indiangrass (one year results), and 55% for alfalfa. Sand lovegrass was susceptible to low rates of soil movement.

SWCRD, ARS, USDA, Manhattan, Kans.

Wiese, A. F., and Rea, H. E. THE EFFECT OF SOIL STERILANTS ON THE WIND ERODIBILITY OF PULLMAN SILTY CLAY LOAM. Agron. J. 52: 707-709. 1960.

The potential wind erodibility of Pullman sicl treated with various soil sterilants in September 1953 was estimated from the second through the sixth winter after application. The sterilants had little effect on residues or soil characteristics the first winter after treatment. The second and third winters after sterilization little plant residue was produced, as a result, wind erodibility was determined by soil clodiness. Monuron applied at 40 lbs. per acre reduced soil clodiness below that of the check. Anhydrous borax, BCM, and sodium chlorate at 2,880, 1,600, and 960 lbs. per acres, respectively, increased soil clodiness. Monuron-treated areas were very susceptible to wind erosion until the fifth winter application. Undisturbed monuron-treated areas were much more susceptible to wind erosion than areas receiving monuron treatments which were sweep tilled and planted to sorghum. Soil treated with anhydrous borax, BCM, and sodium chlorate was moderately erosive the second winter and only slightly erosive the third and fourth winters after application.

Tex. Agr. Expt. Sta., Southwestern Great Plains Field Sta., Bushland, Tex.

Swanson, N. P. NEBRASKA RESEARCH WILL HELP TO CONTROL SOIL EROSION. Nebr. Expt. Sta. Q. 7(2): 3-4. 1960.

Intense rains falling on sloping lands each year cause serious soil loss on both irrigated and nonirrigated land. Control of erosion must be based on a better understanding of how and why erosion occurs. To obtain answers to the many questions encountered, a cooperative study of the factors affecting erosion on row-cropped fields with furrows is being made.

Runoff and erosion have been measured from field plots in many research studies. It has not been practical, however, to measure the velocity of the furrow runoff streams, the depth of flow in the furrows, and other factors under natural rainfall and field conditions. In order to make such measurements, a specially designed sprinkler system has been used to provide artificial rain and runoff in the field.

This equipment provides artificial rain along one side of a line of nozzles several hundred feet long. Each furrow receives a uniform amount of rain along its entire length. This determines the amount of runoff that will be obtained from that furrow. The furrows closer to the line of nozzles get more rain than those farther away, so a range of rainfall amounts is obtained for any one "storm" applied. This makes it possible to study the effect of different rates of rainfall on similar furrows at the same time.

Cross sections of the furrows are measured before and after rainstorms to determine changes in the shape of the furrows. A metal plate which has squares marked on it is set temporarily across the furrow at selected locations and photographed to obtain the furrow cross-section. Recording instruments set at uniform distances along some of the furrows record the depth of flow at that point in the furrow on a chart. A set of electrical instruments permit measuring the velocity of the water movement between various points along the furrows.

Flumes measure the rate of runoff from each furrow, and a recorder on each flume makes a chart of this for each storm. Samples of the runoff are taken to determine how much soil is being removed in the runoff. The total soil losses for a storm can be figured from this information.

Laboratory determinations are made of the erosion samples to find out what parts of the soil (sand, silt, or clay) are being carried off. These parts of the soil can be compared with the amounts of each that were found in the soil on the surface of the field at the start of the experiment.

Intake rates are obtained for the soils on which studies are made. Information such as amount of free water remaining in a furrow at the end of a storm is obtained. The length of time required for runoff from the upper end of the furrow to reach the lower end is also obtained. This information is of great value to engineers and conservationists in designing field and watershed protection structures.

The total information obtained from this work should determine: (1) The maximum furrow grades and lengths that can be permitted in contours or for furrow irrigation without excessive erosion from rainfall; (2) the required terrace intervals for field terraces or contour irrigation; and (3) the furrow sizes required to handle rainfall runoff. It will also provide a yardstick for estimating soil and water losses from row crops.

SWCRD, ARS, USDA, Lincoln, Nebr.

Smith, D. D. RECENT DEVELOPMENTS IN RAINFALL EROSION RESEARCH. Proc. Eleventh Annual Fert. Conf. of the Pacific Northwest, Salt Lake City, Utah. July 13-16, 1960.

This article briefly outlines early rainfall erosion research, tells of recent research, and the plans for additional research on this subject.

SWCRD, ARS, USDA, Beltsville, Md.

Barnett, A. P., and Hendrickson, B. H. EROSION ON PIEDMONT SOILS. Soil Conserv. 26: 31-34. 1960

During the past 20 years, research at the Southern Piedmont Soil Conservation Field Station, Watkinsville, Georgia, has been directed toward the development and testing of practical methods to reduce soil and water losses and restore productivity of the farmlands of the Piedmont. Useful and meaningful data have come from a series of runoff plots on the Cecil soils of 7-percent slope. They represent conditions existing within a 5- to 9-percent slope range, and are typical of the land on which most Piedmont farmers make their living.

The significant results found during the tests at Watkinsville was summarized as follows: (1) Runoff and erosion vary greatly from year to year. This variation is closely related to the frequency of occurrence of excessive-rate or "thunderstorm" rainfall. The period of greatest erosion hazard is the summer months when 55 percent of the average annual erosion occurs. (2) An average of 11 "thunderstorms" each year contain 25 percent of the annual rainfall, produce 56 percent of the annual runoff, and cause 86 percent of the annual soil loss from Cecil soil, capability class IIIe, in continuous cotton. And (3) sod-based rotations have proven to be by far the most effective cropping system developed in the Piedmont for the control of both runoff and soil loss. They supply practical means for both protecting and improving our soils.

SWCRD, ARS, USDA, Watkinsville, Ga.

Terraces

Worley, L. D. PLANNING TERRACE SYSTEMS TO FACILITATE FARM MACHINERY OPERATION. Trans. ASAE 3(1): 68-70, 72. 1960.

In recent years basic changes have been made in planning and adapting terracing systems in the southeast section of the United States. Some of these changes are as follows: (1) More consideration in the selection of land for terracing; (2) a better job of planning and applying adequate outlets; (3) more attention to obtaining better terrace alignment; (4) more consideration to staking terraces to drain from the natural dividing ridge toward the natural drainage depression; and (5) more emphasis to shaping fields and land smoothing.

The character of the rainfall in the Southeast is such that it is not possible to retain on cultivated sloping land all the water that falls. Consequently, terraces and vegative outlets are needed to reduce soil and water losses from the land.

There must be a proper combination of mechanical and vegetative measures to protect and keep the soil productive. Ground cover can do much to make the terrace system more effective; however, ground cover cannot prevent erosion where farm machinery is operated up and down the slope of the land. When this system of farming is employed, it encourages serious erosion.

To reduce this method of farming to a minimum, terrace systems have to be planned and applied in such a manner as to do a more effective job in conserving soil and water, and applied so they will facilitate the use of farm machinery. These are two basic principles that must be kept in mind when land is to be terraced.

In planning terrace systems, there are three basic things that should be recognized when looking over a field: (1) The land-use pattern; (2) the drainage pattern; and (3) the erosion pattern.

The advantage of, installation of, and use of parallel terraces, gradient terraces, and land smoothing are given.

SCS, USDA, Athens, Ga.

Critical Areas

Krammes, J. S. EROSION FROM MOUNTAIN SIDE SLOPES AFTER FIRE IN SOUTHERN CALIFORNIA. Pacific Southwest Forest and Range Expt. Sta. Res. Note 171, 8 pp. 1960.

The night of July 21, 1960, was a hectic one for firefighters setting backfires along the Glendora Mountain Road in a desperate effort to check the Johnstone Fire on the San Dimas Experimental Forest. The men had to be continually alert to dodge large rocks rolling downslope only seconds after the fire passed.

These men were witnessing how fast and furiously erosion begins after a southern California brush fire. Less than a week after the Johnstone Fire, so much soil material had moved down the denuded slopes that debris cones often blocked roads and trails.

In most areas, surface runoff of rainfall is the main cause of soil erosion. In the rugged San Gabriel Mountains, however, we are faced with a two-fold erosion problem: winter scour from surface runoff plus "dry creep" from steep side slopes during the summer.

Side slope erosion directly related to the Woodwardia Fire ranged from 2.2 to 24.7 tons per acre the first year after the fire. South slopes flanking rejuvenated stream channels yielded the most debris, 10 times the pre-burn rate. Nearly 89 percent of the eroded material came during the dry season.

Other study sites showed similar large increases of 4 to 17 times the pre-fire rates. Dry-season debris movement exceeded wet-season movement at all but one of the study sites. However, precipitation during the period of measurement was below normal, and the few gentle rains gave cohesion to the soil rather than winter scour.

The absence of appreciable winter scour in the first year after the burn does not necessarily decrease debris hazard. The eroded debris remains poised in the stream channels until high flows at some later date carry it destructively to the valley below.

Pacific Southwest Forest and Range Expt. Sta., FS, USDA, Berkeley, Calif.

Boyce, S. G., and Neebe, D. J. TREES FOR PLANTING ON STRIP-MINED LAND IN ILLINOIS. Central States Forest Expt. Sta. Tech. Paper 164, 33 pp. 1959.

Seventeen species of trees were found suitable for planting on strip-mined land in Illinois. Ten species were suitable for planting in all parts of the state; seven additional species were suitable for the southern counties. The best survival and growth was obtained where species were carefully selected for the various sites and only the best quality stock was planted.

The species selected and their suitabilities are summarized as follows for all districts:

1. Black Locust--For obtaining a quick plant cover. Can be planted on all sites. Makes the best growth on well-drained lower slopes of moderate acidity. Attacked by locust borer.
2. Cottonwood--For fast growth. Must be planted in pure stands on bare areas. Best growth was on calcareous lower slopes and bottoms.
3. Green and White Ash--For frequently flooded lower slopes and bottoms, and in stands of sweet clover or other low plants. Also for use in hardwood mixtures. Best growth was on lower slopes in northern districts where pH was above 5.5.
4. Silver Maple--For well-drained bottoms and lower slopes of calcareous areas, for underplanting black locust, and for hardwood mixtures. Best growth was in northern districts.
5. Black Walnut--For underplanting black locust and for mixed plantings. Not for pure plantings. Best growth was in northern districts and on well-drained calcareous areas with black locust.
6. Osage-orange--For dense plantings on upper slopes and ridges and for the drier sites in black locust stands. Best growth was in northern districts and on areas with pH greater than 4.5.
7. Eastern Redcedar--An evergreen for windbreaks, Christmas trees, wildlife cover, and wood products. Best growth was in southern districts and on well-drained bottoms. Pure plantings only.
8. Jack Pine--A pine for planting on all sites except poorly drained bottoms and areas subject to flooding. Best growth was in northern districts and on areas with a pH near 6.5. For pure plantings only.
9. Red Pine--For upper slopes, ridges, and well-drained bottoms where pH is more than 5.6. Best growth was in the northern counties. Pure plantings only.

Additional species that can be used for the southern districts are:

1. Sweetgum--For lower slopes and bottoms. Had the straightest stem and the best form of all the hardwoods. For pure plantings or mixed with other hardwoods.
2. Sycamore--For planting where pH ranges from 4.5 to 8.0 and where sweet clover forms a sparce cover. For all slope positions, for pure plantings, and for mixed plantings with other hardwoods.
3. Northern Red Oak--For planting on slopes and well-drained bottoms in mixture with other hardwoods.
4. Yellow-poplar--For underplanting decadent black locust stands. Not for pure plantings.
5. Loblolly Pine--For fast growth on acid (pH 4.5 to 6.9) areas. Must be planted in pure stands. May be damaged by ice storms.
6. Shortleaf Pine--The best pine for planting on strip-mined land in southern Illinois. Best growth on

well-drained areas with pH from 4.5 to 6.5.

7. Virginia Pine--For wildlife cover on acid areas (pH 4.5 to 6.5).

Central State Forest Expt. Sta., FS, USDA, Columbus, Ohio.

Hart, G., and Byrnes, W. R. TREES FOR STRIP-MINED LANDS. Northeastern Forest Expt. Sta. Paper 136, 36 pp. 1960.

During the summer of 1958, survival and growth of tree and shrub species were determined on 22 research plantings on strip-mined lands in the bituminous region of Pennsylvania. These experimental plants were established during the period 1946 to 1949 to determine the species that are best adapted to these adverse sites.

Hybrid poplar, black locust, red oak, Japanese larch, and Banks pine exhibited the best survival and growth. Scotch pine has performed very well, but it has not been widely tested. Red oak has performed well but should be restricted to the lower slopes and protected coves within a bank. Banks pine should not be planted in localities where the pine sawfly is active, unless control measures are planned.

Green ash, white ash, pitch pine, red pine, and white pine were more variable and do not appear well suited for planting on strip-mined lands. The pines are susceptible to damage by certain insects and should not be planted in localities with high incidence of these pests. Both green and white ash have been severly infested with oystershell scale, which materially reduces their vigor.

European larch, Douglas-fir, white spruce, Ponderosa pine, and black walnut have shown poor growth and survival on these test plantings and are not recommended for strip-mine planting.

Good survival and normal development of chokeberry, arrow-wood, silky dogwood, and hazelnut in these tests indicate that successful plantings of these shrubs can be made on strip-mine banks. Patches or strips of these species provide food and cover for small game and aid in holding the soil.

Northeastern Forest, Expt. Sta., FS, USDA, Upper Darby, Pa.

Finn, R. F. TEN YEARS OF STRIP-MINE FORESTATION RESEARCH IN OHIO. Central State Forest Expt. Sta. Tech. Paper 153, 38 pp. 1958.

Strip mining for coal began in Ohio in a modest way in 1915, but it was not until 1940 that it really came into its own. By 1948, more than half the coal mined in the State came from strip mines. Because strip mining leaves the land barren and temporarily nonproductive, this method of mining brought with it a unique problem in land rehabilitation. Unfortunately, such land does not reforest naturally very well.

This paper summarizes the results of the following 10 years of planting studies on coal strip-mined land in Ohio. Some of the things studied were species adaptation, mixed plantings, direct seeding, as well as planting methods and the effect of grading strip-mined land on planted trees. Work was concentrated in southeastern Ohio.

The initial phase of finding ways to put strip-mined land back into productive use has in a real sense been solved. The studies show that a variety of trees and forage plants can be successfully grown on strip-mine banks. There is every reason to believed that eventually this newly restored land will grow satisfactory stands of forest trees and that the products from these stands will be of economic value. Even now some of these juvenile stands furnish posts and Christmas trees. However, these plantations must be properly managed if they are to yield the highest economic returns. Therefore, the emphasis is now shifting from rehabilitation to management. The solution of management problems will occupy a larger share of the efforts of those concerned with the problem of strip-mined land.

Illustrations, tables, and graphs.

Central State Forest Expt. Sta., FS, USDA, Columbus, Ohio.

TABLE .--Comparative rating of species for planting on strip-mined land in Ohio

Species	Overall rating	Remarks
Green ash	Good	Adapted to all plantable strip-mine sites but is best suited to moist sites. On barren banks should be planted in mixture with black locust (25 percent) or other hardwoods.
White ash	Good	For best growth should be planted on lower slopes and bottoms of banks having a high percentage of clay and loam. Will tolerate compaction caused by grading banks having a high clay content. Can be planted in mixture with black locust (25 percent).
Basswood	Fair	Grows best on lower slopes and bottoms. Can probably be planted in mixture (25 percent) with black locust.
Cottonwood	Good - Fair	Adapted to a wide variety of strip-mined land. Good planting stock essential.
Cottonwood (cuttings)	Good	Same as cottonwood. Tests showed that the cuttings survived and grew faster than the seedlings.
Black locust	Good	Better early survival and growth on most sites than any other species tested. On clay sites stands begin to break up after about 7 years because of borer attack. This species is valuable as a nurse tree and as a site improver.
Silver maple	Good - Fair	Adapted to most plantable strip-mined land but makes fastest growth on moist sites. Can be planted with black locust (25 percent). Tends to form multiple sprouts.
Chestnut oak	Fair	Is adapted to drier sites but grows faster on more moist sites.
Northern red oak	Fair	Should be planted on lower slopes for fastest growth. Sites should have a high percentage of soil. Can be planted in mixture (25 percent) with black locust but locust should not be permitted to overtop the oaks.
White oak	Poor	Grows slowly. Should only be planted on medium acid to calcareous sites having high loam and clay content. Should not be planted on ridges or upper slopes.
Osage-orange	Good	Does well on most strip-mined land, either in pure stands or in mixture (25 percent) with black locust.
Hybrid poplars (50 tested)	Good	Suitable for planting on most graded strip-mined land. Survive well and grow rapidly.
Yellow-poplar	Fair	Should only be planted on lower slopes and bottoms of banks composed of loamy and well-drained clayey material. Should not be planted on very acid banks. Can be planted with black locust (25 percent). Locust should not be permitted to overtop the poplar for more than 3 years.
Sycamore	Good	Very suitable for planting moist sites but also grows well on mid-slopes. Can be planted with black locust (25 percent).
Eastern redcedar	Fair	Grows well with black locust or in pure stands on calcareous, strip-mined land. Very limited plantings in Ohio.
Eastern white pine	Fair - Good	Should not be planted with black locust or other species that will overtop it. Plantings should be confined to relatively coarse-textured strip-mine sites having high percentage of soil. Does not grow well on calcareous, fine-textured bank material.
Jack pine Pitch pine	Good Good	Should not be planted with black locust or other species that will overtop it. Will grow on relatively dry ridges but grows faster on lower slopes.
Red pine	Poor - Good	Red pine plantations have been severely damaged by the European pine shoot tip moth. Plantings should not be made in areas of known infestation.
Shortleaf pine	Good	Adapted to a wide variety of strip-mined land but grows best on moderately acid sites. Should not be planted with black locust or with species that will overtop it. Plantings should be confined to the southern half of the State.
European larch	Fair	Should be planted in pure stands. On relatively moist sites containing some coarse-textured material this tree may grow well especially in the northern half of the State.

Cropping Practices

Bruns, V. F., Heinemann, W. W., and Oldemeyer, D. L. CONTROL OF DOWNY BROME IN ALFALFA; AND RELATED STUDIES. U.S. Dept. Agr. Tech. B. 1197, 29 pp. 1959.

Downy brome (Bromus tectorum L.) in alfalfa presents a serious problem because it reduces alfalfa yields, renders the hay less palatable and nutritious, and prossesses awns, which are frequently injurious to livestock.

Downy brome responded markedly to applications of phosphorous on alfalfa plots, and the percentage of downy brome in the first-cutting hay after the treatments was increased significantly.

Controlling downy brome by cultivation without injury to the alfalfa has not proved entirely effective or desirable.

Two out of eighteen herbicides tested gave outstanding control of downy brome in alfalfa. Disodium salt of endothal applied at 6 or 8 lbs. per acre in late fall or early winter gave effective seasonal control of downy brome and, thereby, increased alfalfa yields. Rates as high as 32 lbs. per acre were applied without a significant decrease in alfalfa yields. Sodium salt of dalapon was most effective when applied in early spring, just before the alfalfa shoots began to emerge. The rate of 5 lbs. per acre generally gave moderate downy brome control, whereas 10 lbs. gave good control but caused occasional injury to the alfalfa. The optimum rate may be between 6 and 8 lbs. per acre.

Monuron gave good control of downy brome, but it damaged the alfalfa in 2 of the 3 experiments in which this herbicide was tested. Diuron caused no injury to the alfalfa, but it failed to control the downy brome satisfactorily in the one experiment in which this herbicide was included.

Fall applications of disodium salt of endothal at 8 lbs. per acre desiccated the legume-grass aftermath, and sheep disliked the treated forage. However, forced grazing of the treated aftermath caused no toxic symptoms as measured by certain hematological studies and the overall condition of the animals. Even when very hungry, the sheep refused to consume appreciable quantities of chopped alfalfa hay treated with disodium salt of endothal. They consumed readily and without adverse effects the first-cutting alfalfa hay from an area treated the previous fall with disodium salt of endothal at 8 lbs. per acre.

ARS, USDA, Inform. Div., Washington 25, D.C.

Friesen, G., Shebeski, L. H., and Robinson, A. D. ECONOMIC LOSSES CAUSED BY WEED COMPETITION IN MANITOBA GRAIN FIELDS. II. EFFECT OF WEED COMPETITION ON THE PROTEIN CONTENT OF CEREAL CROPS. Canad. J. Plant Sci. 40: 652-658. 1960.

Economic losses caused by weed competition in Manitoba grain crops were studied on 142 farm fields during a 3-year period, 1956 to 1958 inclusive. Ten paired plots were located in each farm field, one-half of each paired plot being kept weed-free throughout the growing season. Percent protein was determined on wheat, barley, and oat samples collected from 60 of these farm fields. Significant increases in protein content were obtained following weed removal in 22 of the 60 grain fields studied and small increases were noted in most other fields. In the combined analysis of all fields, removal of weeds resulted in significant increases ($P = .01$) in both protein content and yield of wheat, barley, and oats. This suggests that weeds compete very effectively with grain crops for available nitrogen and that reductions in crop yields resulting from weed competition are generally accompanied by reductions in protein content as well.

U. Manitoba, Winnipeg, Manitoba, Canada.

Lang, A. L. CROP, ROTATION: PRACTICAL OR PASSE? Plant Food Review 6(4): 13-15. 1960.

Yields of cultivated crops such as corn and soybeans are usually higher when they follow small grain, meadows, or other non-cultivated crops in rotation than when they are grown in continuous culture.

Adding fertilizers to make up possible deficiencies has not completely overcome those differences. Therefore, it appears that cultivated crops grown in continuous culture do not use plant nutrients as efficiently as when they are grown in alternating sequences with non-cultivated crops.

In seasons when all production factors are most favorable for high yields, differences due to sequences of cropping are frequently negligible. But in growing seasons when moisture or unknown factors put stress on the production facilities of the soil, yields may be widely different for varying cropping sequences. These differences usually favor the alternating systems that include non-cultivated crops.

TABLE 1.--Urbana Rotation Study--1952-59. Eight-year average yields in bushels per acre

	2-year Rotation (Corn, Soybeans)		4-year Rotation (Corn, Soybeans, Wheat, and Hay)	
	No Fertilizer	Lime, Nitrogen, Phosphate, Potash	No Fertilizer	Lime, Nitrogen, Phosphate, Potash
Corn	56	86	61	98
Soybeans	18	24	22	30

TABLE 2.--Six-Year Average Yields From Hartsburg Corn Trials (1954-59)

Rotation	Nitrogen (Pounds Per Acre)		
	None	40	120
Continuous corn	74	81	81
Corn-soybeans-wheat	89	91	94

The importance of recognizing fertilizer deficiencies and adequately caring for them when growing cultivated crops in continuous culture is pointed out by data from experiments at Oblong and West Salem, Illinois. At Oblong, 160 lbs. of actual nitrogen per acre was needed to bring corn yields in a corn-soybean rotation near to those of corn grown in systems alternating with small grain and legumes.

Likewise, at West Salem the complete fertilizer treatment did not bring corn yields in the corn-beans rotation up to those of corn rotated with small grain and legumes.

More important, however, is the observation of extreme losses in corn yields when a nutrient was left out of the treatment for corn when grown in continuous cultivation with soybeans.

These several repetitious examples from experiments are given to support agronomists in diagnosing similar troubles on farmers' fields where fertilization seemed adequate but where yields were unsatisfactory. This situation will be found in season of stress because of continuous cropping to cultivated crops.

Farmers need to keep in mind that adequate applications of plant food alone will not make up for errors in management such as poor cropping patterns, inadequate lime, poor drainage, lack of weed control and insect eradication, unadapted crop variety, overpopulation for the production potential, root pruning by cultivation, or some combinations of these.

Experience has shown that the seed or fertilizer will have a better chance of doing justice to its inherent quality when used on cultivated crops that are alternated frequently with non-cultivated crops.

U. Ill., Urbana, Ill.

Blakely, B. D. CROP ROTATION: PRACTICAL OR PASSÉ? Plant Food Review 6(4): 12, 16-17. 1960.

New information from crop research experiments is making its impact on crop rotation practices. The increased use of commercial fertilizer (particularly nitrogen), improved tillage practices, wider use of crop residues, improved seeding methods, and the development of new herbicides and insecticides have changed our ideas on soil use. No longer is the sequence of crops a requirement in itself. A particular combination or sequence of crops--combined with cultural, management, and mechanical methods--make up a cropping system. Such a system must be designed to control erosion, maintain the soil's productivity and tilth, and to produce optimum economic returns to the farmer.

Soil management principles haven't changed--only the methods employed in achieving good management programs are changing. We still have to contend with problems of erosion, low fertility, salinity, improper pH levels, poor tilth, wetness, and droughtiness. However, we now have a wider selection of alternatives available in coping with these problems.

Continuous growing of low-residue producing crops, such as vegetables, together with intensive tillage, normally leads to soil tilth deterioration, hampers infiltration, and induces excessive erosion, especially on sloping land. Producing low yields of corn and small grains results in a similar situation.

Research studies have shown that soil losses from sloping land will be three to four times more where row crops are grown year after year as compared with those following a good grass-legume sod.

Some types of soil require a rotation including grasses and legumes for one or more years; others can be cropped more intensively, provided steps are taken to keep the soil workable and productive. In addition, there are certain conditions under which a specific crop sequence must be adopted in order to help control plant diseases and insect pests.

More farmers in the Southeastern part of the country are turning to perennial grasses as a means of producing higher yields of tobacco, tomatoes, corn, cotton, peanuts, and similar crops.

When legumes and grasses are not grown, the organic matter needs of the soil must be met through other means. Research results and on-the-farm experience indicate that fertilizers should be added in sufficient quantity to produce high yields of crops producing at least $1\frac{1}{2}$ to 2 tons of dry residues per acre. These residues should be returned to the soil and tillage operations held to a minimum--just enough to prepare a seedbed and to control weeds that cannot be killed by chemical means.

Minimum tillage helps maintain tilth, avoids the creation of traffic pans, and reduces soil losses.

Successful farm management requires the proper use of soils. The more intensively the farmer uses his soil the more exacting and careful he must be with his management practices. In selecting the most suitable cropping system, it is important to know the characteristics of a soil that will affect its use, management, and productivity. Texture, structure, slope, natural drainage, degree of erosion, content of minerals, and organic matter all must be considered.

Farmer experience and research results indicate that deep, well-drained soils will produce high crop yields without sod crops in the rotations where erosion is controlled and the farmer follows good management practices.

On steeply sloping soils, very fine textured soils, or those that are slowly permeable, it is questionable if economic crop production can be maintained without including grasses in the cropping system.

Commercial nitrogen can now be substituted for legume nitrogen on good level soils in order to grow crops of higher economic value, and keep the sloping land in forages for a longer period.

Grasses and legumes still serve to improve soil tilth, increase production, furnish forage for livestock, and help control erosion. They will likely continue as a paying proposition in supplying nitrogen--especially where they can be grown for livestock feed, where continuous row crops are impractical from the standpoint of erosion control, or where organic material is essential for improving the soil.

SCS, USDA, Washington, D.C.

Horner, G. M., Oveson, M. M., Baker, G. O., and Pawson, W. W. EFFECT OF CROPPING PRACTICES ON YIELD, SOIL ORGANIC MATTER AND EROSION IN THE PACIFIC NORTHWEST WHEAT REGION. Published Coop. by Agr. Expt. Stations of Idaho, Oreg., and Wash. and the Agr. Res. Serv., U. S. Dept. Agr., B. 1, 25 pp. 1960.

Soil management experiments conducted over 40 years at six experiment stations in the Pacific Northwest wheat region are summarized. Research concerning the effects of crop rotations, fertilization, and use of organic material are reported.

Crop Yields--Nitrogen is the most important nutrient affecting yields of cereals in this region. Soil moisture is also an important factor, particularly when nutrient levels are adequate. With high levels of available nitrogen, moisture usually becomes the limiting factor, and vice versa.

In the low precipitation zone, the first crop of wheat following green manure crops generally yielded less than the wheat-fallow cropping system. In the intermediate precipitation zone, wheat following sweetclover or alfalfa usually produced less than in the wheat-fallow cropping system. In the high precipitation zone, wheat grown after green manures of legumes or of legume-grass mixture produced high yields in most years.

Regardless of the precipitation zone, yields of the second and subsequent crops of wheat were usually somewhat larger where legumes had been included in the rotation. This differential in yield was greater under high moisture conditions than under low. Alfalfa grown 3 years or more had a longer-lived beneficial effect on the yield of succeeding grain crops than sweetclover and other green manure crops. Sweetclover and alfalfa were more effective than other legumes in increasing the yield of wheat.

Grass grown in a mixture with alfalfa or sweetclover in the high precipitation zone slightly reduced the yields of subsequent wheat crops compared with either alfalfa or sweetclover grown without grass. Under low moisture conditions, the use of grass with a legume usually resulted in slightly higher wheat yields than where the legume was grown alone.

Yield of wheat was markedly affected by the sequence of cropping. In the high precipitation zone, wheat after fallow had yields approximately equal to those following legumes for green manure. Continuous wheat without fertilizer or previous green manure yielded less than half as much as wheat grown after fallow. Wheat following peas produced slightly less than after fallow.

Return of wheat straw to the soil decreased wheat yields slightly under the low available nitrogen conditions in the intermediate and high precipitation zones. Straw had no appreciable effect on yields in the dry zone or under high available nitrogen conditions in the high rainfall zone. Leguminous plant material, barnyard manure, and nitrogen fertilizer had no appreciable effect on wheat yields in the low precipitation zone, but markedly increased yields in the higher precipitation zones.

Soil Organic Matter--Changes in the content of organic matter depended on the amount of organic material and nitrogen incorporated in the soil, the cropping system followed, and the amount of organic matter present at the beginning of the experiment.

The content of soil organic matter increased (or decreased more slowly) with an increase in the amount of carbonaceous material and nitrogen returned to the soil. A combination of both was more effective than either one alone. Crop rotations that had a legume green manure crop or alfalfa as hay maintained organic matter at higher levels than cropping systems such as wheat and peas. Continuous wheat with nitrogen fertilizer maintained organic matter at relatively high levels. Summer fallowing depleted organic matter faster than any other cropping practice.

Whether organic matter was increased or decreased depended on the amount present in the soil in relation to the equilibrium level for the particular treatment. Greater gains (or smaller losses) in organic matter occurred on seriously depleted sites than where the level of organic matter was high.

Runoff and Erosion--The climatic pattern creates a winter erosion problem in the region. No appreciable runoff occurs during the active growing season.

Runoff and erosion losses are influenced by cropping practices which affect such factors as the kind and amount of vegetative cover during the erosion season, soil structural relationships, and the soil moisture.

Most crop rotations that resulted in high crop yields and that also maintained soil organic matter furnished good protection against runoff and erosion. Rotations that included alfalfa and grass were the most effective. Sod crops provided good vegetative cover during a portion of the rotation cycle. Also, these rotations maintained higher rates of infiltration of water into the soil.

Summer fallowing resulted in the highest runoff and erosion. The high content of soil moisture, pulverization of the soil, and depletion of organic matters are factors that caused this situation.

Runoff and erosion losses were reduced by the use of organic material. The effect was greater when the material was left on the surface as a mulch than when plowed under.

Wash. State U., Col. Agr.,Agr., Expt. Sta., Pullman, Wash.

Fenster, C. R. STUBBLE MULCHING WITH VARIOUS TYPES OF MACHINERY. Soil Sci. Soc. Amer. Proc. 24:518-523. 1960.

Stubble-mulch farming has been recognized as the simplest and surest way of preventing wind erosion in the Great Plains. Maintaining residues for adequate soil protection while controlling the weeds and preparing the seedbed has been a major problem in a stubble-mulch program. Reduction of surface residues should be held to a minimum unless they are excessive. Tillage and planting tools have various characteristics in their ability to conserve or reduce residues, to work in heavy residues, to control weeds, to penetrate the soil and keep the soil in good tilth for proper germination and plant growth. Satisfactory stubble-mulch tillage equipment is now available from major implement companies. The correct machines can be selected by making an inventory of the residues at the beginning of the tillage season, and by determining the amount of residues necessary to protect a given piece of land. With proper equipment, knowledge, and ability, a year-round system of managing plant residues can be used in which all tilling, planting, cultivating, and harvesting operations are performed to keep a constant protective cover on the land.

The various types of machinery for stubble mulching are described and illustrated.

Nebr. Agr. Ext. Serv., U. Nebr., Lincoln, Nebr.

Hobbs, J. A., Luebs, R. E., and Bieberly, F. G. STUBBLE MULCH FARMING FOR EROSION CONTROL. Kans. State U. Ext. Serv. C. 289, 12 pp. 1960.

Stubble mulch farming is a system of cultivation and planting which maintains much of the crop residue anchored on the soil surface. The main purpose of this system is to keep enough residue on the surface to protect both crops and soil from damage by wind and water erosion. Subsurface tillage implements are the principal but not the only tools used. This system of farming includes protection of the crop residue from over grazing.

Stubble mulch farming is flexible. The practices vary from season to season, and from area to area. When little vegetation is produced, all possible residue must be kept on the surface. When stubble is heavy, part of it may be incorporated.

Amount of Residue Needed for Wind Erosion Control on Various Soil Textures

Type of residue	Minimum amount of standing stubble required to control wind erosion		
	Silt loams and finer soils	Sandy loams	Loamy sands
	Lbs. per A.	Lbs. per A.	Lbs. per A.
Sorghum stubble	1,500	2,500	3,500
Wheat stubble or growing wheat	750	1,250	1,750

An accurate estimate of the amount of residue on the land is made by weighing the residue to one inch below the soil surface from three separate square-yard areas. The total weight of residue from the three areas, in ounces, times 100, equals the amount of residue in pounds per acre.

Somewhat larger amounts of residue may be needed for effective runoff control.

Different types of equipment are illustrated and described that are needed for tillage and seeding for stubble mulch farming.

Stubble mulch farming is recommended on both hardlands and sandy land in the western half of Kansas.

The techniques described are those recommended for the hardlands of that area.

Ext. Serv., Kans. State U., Manhattan Kansas.

Brady, H. A. AN EVALUATION OF TILLAGE PRACTICES FOR WINTER WHEAT IN THE SEMIARID REGION OF SOUTHWESTERN KANSAS. Soil Sci. Soc. Amer. Proc. 24: 515-518. 1960.

Three methods of seedbed preparation for winter wheat (stubble-mulch tillage, one-way disking, and moldboard plowing) were evaluated for the semiarid region of southwestern Kansas. Although fallow is recommended for the area, both continuous cropping and wheat-fallow sequences were used in the comparison. Measurements of grain yield, soil moisture, evaporation from soil, soil temperature, soil nitrate, and notes concerning runoff and erosion by wind and water were included.

Subsurface tillage effectively controlled erosion by wind and water. Differences in the other factors tested were not statistically significant. On fallowed land slightly higher average yields were produced by one-waying than subsurface tillage or plowing. Subsurface tillage gave the highest yields on continuous cropping. Visual observations indicated that runoff was less from subsurface tillage plots but higher evaporation under the residue mulch left moisture levels nearly equal. Soil temperature averaged slightly higher under a stubble mulch; the soil warmed more slowly in the spring and cooled more slowly in the fall. Nitrate levels were highest on plowed, somewhat lower on one-wayed, and least on subtilled plots. Free nitrate levels were considered an indication of the rate of decomposition of organic matter.

Kans. State U., Manhattan, Kans.

Jamison, V. C., Larson, W. E., and Lovely, W. G. SUBSOILING SELDOM PAYS IN THE MIDWEST. J. Soil and Water Conserv. 15: 247-251. 1960.

Research has shown few benefits from either deep tillage or deep fertilizer placement in the Midwest. These practices sometimes increase yields, but costs increase greatly with the depth of soil treatment. The true value of any yield increase must be considered in relation to costs necessary for obtaining the increase.

The research data available lead to this general conclusion for the North-central States: It is doubtful if expensive subsurface soil treatments will give economic returns for corn, alfalfa, or other forage crops where good fertility and management practices are used on the normal surface plow layer.

SWCRD, ARS, USDA, Columbia, Mo.

Meyer, L. D., and Mannering, J. V. MINIMUM TILLAGE FOR CORN: ITS EFFECT ON INFILTRATION AND EROSION. Agr. Engin. 42: 72-75, 86-87. 1961.

Minimum tillage has recently gained popularity as a farming practice. Acceptance of this reduced tillage practive has been largely based on decreased cost of operation, although various other desirable features have been advanced. One of the claimed advantages, soil and water conservation, has been based more upon observation and an examination of the resulting physical conditions than on controlled field research. To obtain research information on the soil and water conservation characteristics of minimum tillage, a five-year study was initiated near Lafayette, Ind., in 1959. Plots with conventional tillage and various types of minimum tillage were established for study with simulated storms produced by the rainulator, a field-plot rainfall simulator. Subsequent cultivations as compared to no cultivation were also included in the study. This paper reports the results for the initial year of this research.

The treatments were applied up and down a 4½ to 5 percent slope, and more than 5 in. of simulated rainfall were applied in a total period of 2 hours during each of three series of runs. This is a more intense rainfall than occurs in an average year. However, large intense storms cause the most serious soil losses and are the type of storms for which protection from erosion is most important. Although predictions of average annual losses based upon such storms cannot be made with the accuracy of long-term studies with natural rainfall, the reported results provide useful information on the relative protection from erosion afforded by the various tillage conditions studied.

The following conclusions are based on the more significant information found: (1) Minimum tillage with cultivation very significantly increased the amount and rate of infiltration and decreased the soil loss as compared to conventional tillage with cultivation. The reduced soil loss for minimum tillage during the initial year after meadow is largely attributed to the reduced runoff resulting from increased infiltration. (2) No important differences in infiltration and soil loss were found among the three types of minimum tillage studied during the initial year. (3) Elimination of a severe crust by cultivation significantly increased the amount and rate of infiltration and decreased the amount of soil loss as compared to no cultivation. Severely crusted soil surfaces continued to erode at high rates. And (4) soil losses from corn were much less by harvesting time than during the earlier periods of the crop year.

SWCRD, ARS, USDA, Lafayette, Ind.

Ackerson, P. O. MINIMUM TILLAGE DEEMED EFFECTIVE IN THE MIDWEST. Crops and Soils 13(3): 22. 1960.

Minimum tillage is being accepted by Midwestern farmers producing corn and soybeans, because it pays off in reduced runoff and erosion losses, less soil compaction, fewer weeds, less labor, and lower cost. The yields remain equal to or higher than those obtained with conventional tillage.

Other advantages of minimum tillage are that the ground can be plowed and planted sooner after a rain than if conventional tillage is used; distant fields can be plowed and planted without transporting disks and harrows; and later and fewer cultivations provide more time to harvest hay at the ideal maturity stage.

The biggest benefits and yield increases from minimum tillage have been obtained on heavy soils, where compaction is more of a problem.

Minimum tillage also kills numerous weeds at planting time and the loose soil between rows hinders germination of other weed seeds.

An estimated saving of $5 per acre in time, fuel, and machinery costs is usually possible when the crop is planted with only one or two trips across the field.

Some of the minimum tillage methods used by Midwest farmers include: (1) plow, then wheel-track plant; (2) plow, then plant using a strip-tillage unit in front of the planter runners; (3) plow and plant in one operation with the planter attached behind the plow or to the side of the tractor; and (4) plow with leveler or clod buster attached, then plant. A seed press wheel may be used with any of these methods.

SCS, USDA, Goshen, Ind.

Ryder, G. J. STRIP PROCESSING--NEW CORN TILLAGE SHORTCUT. Plant Food Review 6(3): 6-7, 25-26. 1960.

One of the newer wrinkles in land preparation and a recent entry on the growing list of minimum tillage methods is strip processing. This shortcut involves working plowed land in narrow strips for a desirable seedbed without overworking the rootbed between the corn rows.

In strip processing, a narrow band of soil 5 to 7 inches deep and 8 inches wide is prepared for normal seed germination and emergence. This is accomplished by mounting a 3-wheel rotary hoe attachment just ahead of the planter shoe. The area between the strips is left undisturbed.

With strip processing equal stands have been obtained under a variety of soil conditions in Ohio during the past several years.

On winter-plowed ground that has had time to settle, from 100 to 200 lbs. of weight is needed over each unit in order to force the attachment into the ground. This depends, of course, upon the soil type and soil condition. The weight requirement on freshly plowed ground that has not settled or been compacted has been found to range from 75 to 150 lbs. per unit.

No implement has proven superior to the moldboard plow in preparing a good seedbed. Plowing should be done when the soil moisture is at the proper level for maximum fracturing of the furrow slice. A properly operated plow that is correctly adjusted will leave the soil in a firm, crumbly state, free of air pockets. Any method of seedbed preparation depends upon a good job of plowing.

The strip process method reduces water runoff as compared with the conventional seedbed preparation. When the middle of the rows is left undisturbed, water penetrates into the plow layer very rapidly.

Following some high intensity rainfalls, effects of erosion are much more pronounced on conventionally tilled seedbeds, as compared with strip-processed areas.

Small yield differences cannot be measured unless equal stands are obtained. In the accompanying table, corn stands are compared for strip-processed plots and conventionally fitted plots at 50 locations in 1959. The plant population was approximately 14,000 plants at harvest.

Strip Processing Outyields Conventional Methods

Comparison of corn stands and yields on 50 paired plots using strip processing and conventional seedbed fitting, 1959

Soil type	No. of plots	Strip process stand (+ or -)	Yield		Yield difference (+ or -)
			Strip processed	Conventional seedbed fitting	
Brookston	16	+1400	110	99.0	+11
Crosby	10	- 300	84	79.4	+ 5
Celina	5	+ 900	105	91.0	+14
Miami	5	+ 400	89	101.0	+ 4
Hoytville	4	- 600	103	103.0	+ 2
Other	10	+ 200	99		- 4
1959 Average		+ 400	98.3	93.0	+ 5.3

Farmers using the strip-process method of preparing seedbed for corn are reporting a saving of $3 to $6 per acre in their seedbed preparation. The operation also enables the farmer to use less equipment to prepare the seedbed and plant corn. On larger farms, the extra tractor operator and equipment can be performing other farm tasks during the corn planting season.

The strip processing technique of preparing a seedbed for row crops has proved satisfactory on fall-plowed and spring-plowed soil. This does not create a peak labor season and it permits farmers to use 2-row or 4-row equipment at planting time.

Ext. Agron., Ohio Agr. Expt. Sta., Wooster, Ohio.

Buie, T. S. ASHES OR MULCH. Better Crops With Plant Food 44(4): 34-36. 1960.

Until recently the common practice of farmers throughout the Coastal Plains of Georgia and the Carolinas was to burn the straw as soon as possible after grain harvest, then plow and harrow the land in preparation for planting of soybeans. A method that is both wasteful and time-consuming.

Now, thanks to methods pioneered by J. T. McAlister, and the perfection of suitable equipment, the whole job can be done in one operation.

Beans are planted in lister furrows, wide enough to permit early cultivation within the furrow. The straw in the balks between the rows is not disturbed but covered with loose soil as the furrows are made. By the time the middles are plowed out in the later cultivations the straw has all but decomposed.

Benefits of this method of planting are: (1) Plant residues are returned to the land; (2) soil moisture is conserved; (3) beans can be planted earlier; (4) there are fewer weeds to combat; and (5) time and labor are saved at an extremely busy time.

Farmers who use this method of conservation planting say their yields are as good as, or better than, where the beans are planted in the conventional manner. And they estimate a saving of from $4.00 to $8.00 per acre--all profit.

SCS, USDA, Columbia, S. C.

Botov, T. G. RADICAL IMPROVEMENT OF SOLONETZIC AND PODZOLIC SOILS BY REDISTRIBUTION OF THE SOIL HORIZONS. Soviet Soil Sci. 5: 591-596. May 1959.

Two three-layer plows and one soil improvement cultivator are described and illustrated that have proven successful in keeping the humus horizon at the surface but reversing the podzolic and illuvial horizons in podzolic soils, as well as the solonetz soils.

As a result of cultivation with the three-layer plow a number of important agricultural improvements of podzolic and solonetzic soils are achieved simultaneously which promote increased fertility. In podzolic soils: (1) The podzolic horizon harmful to agricultural crops is displaced downward and replaced with a portion of the illuvial horizon. This permits us to thicken the cultivated layer at less cost for organic and mineral fertilization; (2) the moisture, nutritional, and aeration regimes of the soil are improved; and (3) a general improvement of the cultivated layer is achieved which is most favorable for the growth of agricultural crops.

This treatment has the following effects on solonetzic soils: (1) A marked reduction in the solonetzic characteristics of the upper layer, and the soil becomes more fertile when plowed only once with the three-layer plow; (2) the solonetz and solonetzic horizon, which is impermeable to water, is broken up and redistributed; and (3) the necessary condition is created for tilling solonetz soils using their own calcium carbonate from lime (and gypsum).

If solonetzic and podzolic soils are cultivated with the three-layer plow only once, in the course of time the soil becomes compacted, and the moisture, nutritive, and aeration regimes of the soil deteriorate. It is necessary to maintain deep-plowed podzolic and solonetzic soils in the mellow state by means of periodic cultivation without the moldboard.

Amer. Inst. Biol. Sci., 2000 P ST. N. W., Washington 6, D. C.

Carter, J. D. THE ROOT PLOW. Land & Water Contracting. 2(12): 19-20. 1960.

About 1935, a method of plowing brush out by the roots was used for the first time. The method was slow and costly, but effective. Where other techniques had failed--serving only to aggravate the condition, causing brush to spread more rapidly--root plowing showed real promise. Mesquite and other scrub trees died and didn't come back.

Today, 25 years after this experiment with crude implements, root plowing has become the accepted rangeland regeneration practice throughout much of the West. An estimated half million acres annually are being reclaimed by this method. Unfortunately, at the present rate of brush encroachment, this is barely enough to offset new brush. In the 17 states which compose the "Greater West" there are 369 million acres of brush-infested land.

The modern root plow is a shallow V-shaped cutting blade pulled laterally through the soil by a track-type tractor. It travels at a predetermined depth, severs root systems from above-the-grounds growth, and breaks up hard-pan. Fins attached to the cutting blade push the severed roots to the surface, exposing them to the sun without burying valuable top soil.

Present-day root plows are capable of cutting a 12-foot swath to a depth of 36 inches at rates up to 2.5 acres an hour. For most effective results, root systems must be severed at the root collar. Therefore, depth control is important, and modern plows have multiple depth control settings.

Treating rangeland with the root plow opens up the soil, makes it porous and increases tremendously its water-absorbing capacity. Grass seed distributed mechanically during the plowing operation, sprout at the first rain and get full advantage of available moisture. With adequate rainfall, natural cover is soon restored and erosion virtually eliminated.

Ranch owners who have tried root plowing are enthusiatic about its results. One west Texas cattleman said recently that he now gets more actual grazing from a 20-acre plot, root plowed several years ago, than he does from the rest of his 325-acre range.

Fleco Corp., Jacksonville, Fla.

Fertility Requirements For Conservation Farming

Scholl, W., Davis, M. M., and Wilker, C. A. CONSUMPTION OF COMMERCIAL FERTILIZERS AND PRIMARY PLANT NUTRIENTS IN THE UNITED STATES YEAR ENDED JUNE 30, 1959. U. S. Dept. Agr., Agr. Res. Serv. ARS 41-19-3, 23 pp. 1960.

Consumption of fertilizers and primary plant nutrients (N, P_2O_5, K_2O) are reported for individual States including Hawaii, the District of Columbia, and Puerto Rico, for the year ended June 30, 1959. Only incomplete data were available for Alaska and the Virgin Islands for this period and are not included in the quantities cited in this report. However, fertilizers known to have entered Alaska and the Virgin Islands in 1958 totaled 2,838 tons and 888 tons, respectively. Presumably these tonnages approximate all commercial fertilizer consumed in these areas.

Information was obtained from: (1) Manufacture on the tonnage of each kind and grade of product shipped to agents, dealers, and consumers; (2) distributors and custom applicators of anhydrous ammonia and nitrogen solutions; (3) fertilizer brokers; and (4) tonnage reports issued by the respective States.

The total quantity of fertilizer consumed in the year ended June 30, 1959, was 25,312,672 tons. It comprised 24,089,468 tons of products containing one or more of the primary nutrients and 1,223,204 tons of secondary and trace nutrient materials. Consumption of fertilizers containing primary nutrients was 11.7 percent more than 1957-58. The quantity of the secondary and trace nutrient materials was 30.2 percent more than 1957-58.

The increase in total consumption in 1958-59 was due to substantial increases in both mixtures (1,716,004 tons, 12.0 percent) and in direct-application materials (797,429 tons, 11.0 percent). Consumption of both classes of fertilizers increased in most regions.

Although the national increase in consumption of primary-nutrient fertilizers was substantially higher than for any previous year, decreases or no change occurred in nine of the 51 areas indicated. In comparison with 1957-58, increases were as high as 47 percent (Kansas), whereas the maximum decrease was seven percent (Utah).

Tables.

ARS, USDA, Inform. Div., Washington 25, D. C.

Pratt, P. F., Chapman, H. D., and Garber, M. J. GAINS AND LOSSES OF NITROGEN AND DEPTH DISTRIBUTION OF NITROGEN AND ORGANIC CARBON IN THE SOIL OF A LYSIMETER INVESTIGATION. Soil Sci. 90: 293-297. 1960.

Data on gains and losses of N and on total N and organic C content of the soil of a lysimeter investigation are presented and discussed. Significant amounts of N were fixed where annual winter legumes were grown. The amounts of N fixed by legumes decreased with increase in amounts of N added. There was no evidence of fixation or volatilization of N with applications of cereal straw or with mustard cover crop in combinations with 0, 100, and 200 lbs. N per acre. Organic C and total N in the surface soil (0 to 6 inches) increased linearly as a function of time after cropping commenced. In soil of the 6- to 12-inch depth a decrease was followed by a slight increase. At all lower depths organic C and total N decreased rapidly, but equilibrium levels were attained 13 years after the lysimeters were filled.

U. Calif., Citrus Expt. Sta., Riverside, Calif.

Bardsley, C. E., Sanford, J. O., and Jordan, H. V. STUDY OF RESIDUAL EFFECT SHOWS NITROGEN MUCH MORE EFFECTIVE WHEN APPLIED IN SPRING. Miss. Farm Res. 23(12): 2, 7. 1960.

Nitrogen broadcast in November at Poplarville, Mississippi (Ruston sl) for four years and at Brookville (Houston c) for three years was only 45 percent as effective as nitrogen applied the following spring when measured by yield response of first-year corn.

In terms of nitrogen recovered in the corn crop and a succeeding oat crop, 100 lbs. of nitrogen as ammonium nitrate applied in November was 83 percent as effective as a similar treatment applied in the spring.

There were no consistent differences among the five sources of nitrogen used for fall application. However, at Brooksville, ammonium nitrate and sodium nitrate tended to produce somewhat more as an average than did either ammonium sulfate or urea. There were only slight differences in yield among the sources at Poplarville when yields were averaged over the four-year period. Nitrate of soda performed abnormally poor in 1959 at Poplarville.

Appreciable losses of nitrogen occurred in runoff from the fine textured Houston c at Brooksville during the interval between application in the fall and planting time. Runoff losses on the Ruston sl at Poplarville were negligible. Despite the differences in loss of nitrogen in runoff at the two locations, other losses of nitrogen were such on the sandy soil that the overall efficiency of the fall applications at the two locations was essentially equal. The data indicate that these losses are not simply due to leaching of nitrogen from the root zone.

Recovery of spring-applied nitrogen by the fertilized crop decreased with increasing rate, amounting to about 40 percent at recommended rates of application. The economic implications of this low efficiency emphasizes the necessity for development of management practices for improved utilization of applied nitrogen by the fertilized crop.

Some carry-over of spring-applied nitrogen as ammonium nitrate applied for corn was measured in succeeding crops following the corn. Average nitrogen recoveries by the succeeding crops of 7, 14, and 21 lbs. were measured from original applications of 100, 150, and 200 lbs. of nitrogen, respectively. There were individual years when the nitrogen recovered was considerably higher than average values. This emphasizes the need for soil tests which would evaluate residual nitrogen.

Miss. State Col., Agr. Expt. Sta., State College, Miss.

Raney, W. A. THE DOMINANT ROLE OF NITROGEN IN LEACHING LOSSES FROM SOILS IN HUMID REGIONS. Agron. J. 52: 563-566. 1960.

Loss of bases from the soil has become a factor of increasing concern in many parts of the humid region as a result of inadequate liming programs and the greatly increased use of acid-forming nitrogen fertilizers.

Published data on the amount and chemical composition of drainage waters from lysimeters was studied to learn more about the loss of bases. This analysis leads to the conclusion that nitrogen accounts for the majority of bases that are lost.

Total amount of water passing through the soil is not important. Rather, it is leaching that occurs after a build up of nitrate in soils. Other anions such as sulfur or chlorine are not important factors in humid region soils because of small amounts present in soil solution as compared to nitrates.

SWCRD, ARS, USDA, Beltsville, Md.

Yoshida, D., and Takahashi, T. INFLUENCES OF NITROGEN NUTRITION ON NICOTINE SYNTHESIS IN TOBACCO PLANT. Soil and Plant Food 6(1): 1-6. 1960.

Effects of nitrogen levels on the nicotine synthesis were studied in a field experiment.

The effect of nitrogen levels on the nicotine contents was not marked until topping time, but after topping there were sharp increases in the nicotine contents and the effect appeared evident. Nitrogen contents were higher at the higher levels of nitrogen at all growing stages and decreased with progress of growth.

After a great portion of nitrogen was absorbed, increased synthesis of nicotine occurred. Accumulation of nicotine was simultaneously accompanied by the translocation of nitrogen from leaves to root after topping.

The effects of nitrogen levels were more remarkable on the nicotine contents than on the nitrogen contents in flue-cured leaf.

Chlorogenic acid contents were decreased by the increased supply of nitrogen and negatively correlated with nicotine contents.

Hatano Tobacco Expt. Sta., Japan.

Rubins, E. J., Hawkins, A., and Brown, B. A. BY-PRODUCT WOOL AS A SOURCE OF FERTILIZER NITROGEN. Soil Sci. 90: 290-292. 1960.

The availability of nitrogen derived from by-product wool materials was compared with that derived from castor pomace, cottonseed meal, and soluble nitrogen sources in a series of laboratory, greenhouse, and field experiments.

In a greenhouse pot experiment with oats and in a laboratory nitrification study, the availability of nitrogen from wool was similar to that from cottonseed meal but less than that from castor pomace. In another nitrification study on a different soil, wool was superior to castor pomace. When wool dust (13.9 percent N) was diluted with rayon to give a mixture containing 10.0 percent, the availability of the nitrogen was materially decreased.

Field studies with potatoes indicated that wool was equal to castor pomace when these materials were used to provide one-third the total nitrogen application.

Field applications to lawn plots in the spring indicated that the nitrogen from wool becomes available more slowly than that from castor pomace but has a greater lasting effect than nitrogen from either castor pomace or urea.

Storrs Agr. Expt. Sta., Storrs, Conn.

Silva, J. A., Darroch, J. G., and Humbert, R. P. ECONOMIC EVALUATION OF YIELD RESPONSE OF SUGAR CANE AS A FUNCTION OF SOIL POTASSIUM AND OF SUPPLEMENTAL POTASH. Soil Sci. 90: 178-184. 1960.

The results of 22 potash experiments on the island of Hawaii and 90 potash experiments on the island of Kauai harvested from 1950 to 1957 are summarized. Polynomial yield equations, which included terms for soil potassium (K), the square root of applied potash ($\underline{k}^{1/2}$), and their product ($K\underline{k}^{1/2}$), were developed to describe the yield response surfaces for each of these islands. These equations explained 63.5 percent and 61.8 percent of the variation in yield on Hawaii and Kauai, respectively. Cost data were obtained from a plantation on each island, and an economic evaluation was made of the incremental yield increases from potash applications. This economic evaluation of the yield response surface allows the agronomist to make recommendations for potash applications over a range of soil potassium levels.

Paper No. 83, J. Series, Agr. Expt. Sta., U. Hawaii, Honolulu, Hawaii.

Jacob, K. D. FIFTY YEARS OF SUPERPHOSPHATE IN THE UNITED STATES. Commercial Fert. and Plant Food Indus. 101(3): 24-30. 1960.

A discussion and a review of the literature on superphosphate production and use in the United States in the last fifty years.

Fert. Lab., SWCRD, ARS, USDA, Beltsville, Md.

Jackson, J. E., and Burton, G. W. A FIVE-YEAR COMPARISON OF ROCK PHOSPHATE AND CONCENTRATED SUPERPHOSPHATE FOR SEVERAL FORAGE CROPS. Agron. J. 52: 692-694. 1960.

Two grasses and 4 legumes were established on a virgin Rains soil at Tifton, Georgia, in 1952. Single applications of rock phosphate with and without lime and concentrated superphosphate with lime were made at rates ranging from 300 to 1,200 lbs. of P_2O_5 per acre. Concentrated superphosphate was also applied annually at rates of 15, 30, 60, and 120 lbs. of P_2O_5 per acre. After 4 years of forage production, the annual forage dry-matter yields indicated more residual phosphorus on rock-phosphate plots than on plots receiving an equal initial rate of P_2O_5 (300 lbs. per acre) from concentrated superphosphate. The application of $\frac{1}{2}$ ton per acre of lime resulted in sweet clover utilizing rock phosphate more efficiently than the other legumes. The others, in order of decreasing efficiency, were crimson clover, ladino clover, and big trefoil. On unlimed soil, trefoil was the most efficient in rock-phosphate utilization. Initial applications of 600 lbs. per acre of P_2O_5 from rock phosphate, supplemented with 60 lbs. from concentrated super, gave excellent yields of all legumes each year. Bahiagrass and dallisgrass responded similarly to each of the different phosphorus treatments.

This study indicates that while concentrated superphosphate was generally more efficient than rock phosphate in supplying phosphorus for the forages studied, the difference was not as great as might be expected. These results suggest that the use of rock phosphate might be economically feasible, as compared with superphosphate, on some phosphorus-deficient soils without a serious sacrifice in forage production. The best results were obtained where either large quantities (1,200 lbs. per acre of P_2O_5) were applied initially or where a medium quantity (600 lbs. per acre of

P_2O_5) was applied with 60 lbs. of P_2O_5 per acre from concentrated superphosphate added as a supplement. The choice of forage species should also be an important consideration in the use of this material.

U. Ga. Agr. Expt. Sta., Coastal Plain Expt. Sta., Tifton, Ga.

Digar, S., and Mandal, A. K. SOIL PHOSPHORUS FRACTIONS AS AFFECTED BY ANNUAL APPLICATION OF BONEMEAL AND THEIR INFLUENCE ON YIELD OF PADDY. Soil Sci. 90: 227-231. 1960.

The soils and crop yields of a 10-year experiment with bonemeal, at P_2O_5 doses of 0, 20, 40, and 60 lbs. per acre, on paddy were analyzed according to treatment. Composited soil samples for each treatment were analyzed for soil phosphate fractions soluble in 0.5 N acetic acid, 0.25 N sodium hydroxide, and 2 N sulfuric acid solution to ascertain how much of the P_2O_5 added in bonemeal becomes available to crops, and how the relative amounts of the different soil phosphate fractions are affected by the continuous application of bonemeal and to what extent these fractions influence crop yield.

Yields of grain and straw under the different treatments were analyzed for their P_2O_5 content. From the P_2O_5 contents of grain and straw of paddy, only a fraction of the added P_2O_5 was found to be available to plants, the percentage of availability, as calculated from the amounts taken up by the plant, being only 7.32, 9.24, and 9.01 percent, for doses of 20, 40, and 60 lbs. P_2O_5, respectively.

From the results of an analysis of the soil, 0.5 N acetic-acid-soluble phosphate and 0.25 N sodium-hydroxide-soluble organic phosphate were not found to accumulate in the soil. The 0.25 N sodium-hydroxide-soluble inorganic phosphate and the 2 N sulfuric-acid-soluble phosphate do accumulate in the soil.

State Agr. Res. Inst., West Bengal, India.

Mitsui, S., and Ishizuka, K. DYNAMIC STUDIES ON THE NUTRIENT UPTAKE BY CROP PLANT: XXIX. ON THE MECHANISMS OF UPTAKE AND TRANSLOCATION OF $H_3P^{32}O_4$ IN THE ROOTS OF WHEAT SEEDLINGS. Soil and Plant Food 6(1): 7-15. 1960.

The mechanisms of phosphate uptake by roots of wheat seedlings and phosphate translocation through the roots to the shoots was studied and the results summarized as follows:

1. It was clarified that phosphates absorbed by the crop roots were mainly acid-soluble, and as far as the period of P-32 application to the roots was short, most of them were acid-soluble organic phosphates. Acid-soluble organic phosphates included nucleotides like ATP and sugar esters such as hexose-6-phosphates (HMP) and fructose-1, 6-diphosphate, especially much quantities of HMP.
2. P-32 movement from the roots to the shoots correlated with the decrease in these acid-soluble organic phosphates.
3. The effects of several organic compounds, substrates, or inhibitors of the metabolic reactions in the crop plants, on the intake and upward movement of P-32 have been investigated. Glucose, glucosamine, pyruvate, succinate, citrate, phlorizin, monoiodoacetate, sodium fluoride, and ophenanthroline reduced or inhibited the translocation of P-32, but malonate, trans-aconitate and HMP did not reduce it. P-32 movement was also reduced by oxygen aerating.
4. The mechanisms of the translocation of phosphorus through the root

cells were discussed, under the consideration of respiratory systems of the roots.

Dept. Agr., U. Tokyo, Tokyo, Japan.

Thaung, M. M. RELATIVE ABSORPTION OF PHOSPHORUS BY RICE PLANTS FROM NATIVE AND ADDITIVE SOURCES, USING RADIOACTIVE PHOSPHORUS AS A TRACER. Soil Sci. 90: 284-289. 1960.

The best time to apply fertilizer to a rice crop in Burma is shown to be around the transplanting period. $NH_4H_2P^{32}O_4$ was used to study the time effect on grain yield and the phosphorus uptake by plants from soil and fertilizer at three varying levels of fertilizer applications, made separately on the 9th, 54th, and 80th days after transplanting.

Linear relationships, both direct and inverse, between fertilizer or soil phosphorus utilization and rates of fertilizer application were obtained for 14 weeks. In these relationships the probability of a direct correlation between degree of phosphorus unsaturation of the exchange complex and increased utilization of fertilizer phosphorus was suggested.

During the first 7-9 weeks after transplanting, plants increasingly absorbed more fertilizer phosphorus than soil phosphorus; from that point on, the reverse was true at all levels of fertilization studied. From the 9th or 10th week the trend of relative absorption of phosphorus by plants from both sources appeared to be practically similar in spite of differences in time of fertilization. During weeks 7-9, the phosphate-supplying capacity of the soil of the transplanted plot dropped to a low point, but thereafter rose until, around the flower primordial initiation and floral emergence stages, it reached peak values.

The best yield, found to result from fertilization 9 days after transplanting, was apparently due to an early and efficient plant utilization of more fertilizer phosphorus and also ammoniacal nitrogen, by which growth and reproduction was improved. It is tentatively suggested that fertilization with ammonium dihydrogen orthophosphate within 9 days after transplanting will produce beneficial effects on yield.

Union Burma Atomic Energy Center, Burma.

Runge, E. C. A., and de Leon, L. DISTRIBUTION OF MANGANESE IN A BIO-TOPO SEQUENCE OF SOUTHEASTERN IOWA SOILS. 67: 232-236. 1960.

Manganese extractable by sodium hydrosulfite was determined for 9 soil profiles of a bio-topo (vegetation and drainage) sequence in southeastern Iowa. The distribution of manganese in the soils studied is influenced by vegetation, drainage, and pH. Under prairie vegetation the manganese is evenly distributed with depth in the well-drained soil, but with increasing wetness of the soil profile, manganese is apparently lost from the A_1 horizon and accumulates in the lower part of the B horizon. Manganese accumulates in the A_1 and A_2 horizons of the well-drained soils developed under forest vegetation, but in profiles on increasing wetness the amount of manganese in the A_1 and A_2 horizons decreases and the amount of manganese in the lower B horizon increases. The distribution of manganese in the transition prairie-forest soils was intermediate between soils developed under prairie vegetation and those developed under forest vegetation.

Iowa Agr. and Home Econ. Expt. Sta., Ames, Iowa.

Boawn, L. C., Viets, F. G., Jr., Crawford, C. L., and Nelson, J. L. EFFECT OF NITROGEN CARRIER, NITROGEN RATE, ZINC RATE, AND SOIL pH ON ZINC UPTAKE BY SORGHUM, POTATOES, AND SUGAR BEETS. Soil Sci. 90: 329-337. 1960.

Data are given for a field experiment in which Zn uptake by crops was determined over a 4-year period. Soil treatments consisted of five rates of Zn in factorial combination with three N carriers, each at three rates.

The influence of N carrier on zinc uptake varied with crop grown. Ammonium sulfate increased zinc uptake as compared to $Ca(NO_3)_2$ when the crop was grain sorghum or potatoes, but this effect was not shown when the crop was sugar beets. Where the N carrier effect was observed, it was found to be most closely correlated with changes in soil pH, with Zn uptake increasing as the soil became acid and decreasing as the soil became more alkaline.

Zn applied to the soil as ZnSO4 and incorporated into the 0- to 8-inch depth was converted to forms not extractable with 0.1 N HCl at rates which varied from 0.3 p.p.m. annually, when 2 lbs. per acre was applied, to 1.0 p.p.m. annually, when 16 lbs. per acre was applied over the 3-year period following application. Samples taken after 5 years showed a fairly high percentage of the 8 and 16 lbs. per acre Zn applications still present in acid-extractable form.

SWCRD, ARS, USDA, Prosser, Wash.

Ahmed, S., and Evans, H. J. COBALT: A MICRONUTRIENT ELEMENT FOR THE GROWTH OF SOYBEAN PLANTS UNDER SYMBIOTIC CONDITIONS. Soil Sci. 90: 205-210. 1960.

The effect of small amounts of Co on the growth of soybean plants, under symbolic conditions, were investigated in three different experiments. Plants were grown under controlled conditions in highly purified nutrient solutions lacking combined N and were forced, therefore, to depend upon symbiotic nitrogen fixation. Plants in culture solution without added Co were severely retarded in growth and displayed a chlorosis of leaves similar to that caused by N deficiency. Four of 16 Co-deficient plants died as a result of the severe symptoms. The addition of 0.1 to 1.0 parts per billion of Co to nutrient solutions throughout the growth period in plant growth. Also, the addition of small amounts of Co to severely deficient plants cured the symptoms on all new growth within a period of 10 to 21 days. No evidence has been obtained that V, Ni, Ga, Al, or a series of 8 elements presumed to have been removed by the purification procedure, would substitute for Co as a necessary mineral for the symbiotic growth of soybean plants.

In addition to the growth response from traces of Co, analyses indicated that the percentage total N in shoots and the chlorophyll content of leaves of deficient plants were markedly decreased. Nodules from plants grown in culture solutions supplied with Co contained much greater concentrations of vitamin B_{12} than those from plants grown in Co-deficient solutions.

It is concluded that the results of experiments summarized in this paper provide strong evidence that Co is an essential element for the growth of soybean plants under symbiotic conditions. The possible requirement of the element for nonlegumes or for legumes supplied with combined N remains an open question and is under investigation.

N. C. Agr. Expt. Sta., Raleigh, N. C.

Brown, J. C., Tiffin, L. O., and Holmes, R. S. COMPETITION BETWEEN CHELATING AGENTS AND ROOTS AS FACTOR AFFECTING ABSORPTION OF IRON AND OTHER IONS BY PLANT SPECIES. Plant Physiol. 35: 878-886. 1960.

Plant species differ in their capacity to absorb iron from chelating agents. In vitro experiments demonstrated a competition between chelating agents for iron. In vivo experiments showed that roots react like chelating agents in their capacity to compete for the iron in a growth medium. As the molar concentration of chelating agent was increased to exceed that of iron, the amount of iron absorbed by the plant decreased. The competitive effect of chelating agent was overcome by adding more iron to the nutrient solution. The concentration of iron and the concentration of chelating agent in a growth medium are discussed as controlling factors affecting the absorption of iron and other nutrient elements by plants.

Mineral Nutr. Lab., SWCRD, ARS, USDA, Beltsville, Md.

Salinity and Alkali Problems

Pearson, G. A. TOLERANCE OF CROPS TO EXCHANGEABLE SODIUM. U.S. Dept. Agr., Agr. Inform. B. 216, 4 pp. 1960.

This information bulletin: (1) Defines exchangeable sodium; (2) describes the effects of exchangeable sodium on soil properties and the growth of plants; (3) gives the relative tolerance of some crops to exchangeable sodium; and (4) explains how crop growth can be improved on sodic soils.

ARS, USDA, Inform. Div., Washington 25, D. C.

TABLE .--Tolerance of Various Crops to Exchangeable-Sodium-Percentage

Tolerance to ESP[1] and range at which affected	Crop	Growth response under field conditions
Extremely sensitive (ESP = 2-10)	Deciduous fruits	Sodium toxicity symptoms even at low ESP values.
	Nuts	
	Citrus	
	Avocado	
Sensitive (ESP = 10-20)	Beans	Stunted growth at low ESP values even though the physical condition of the soil may be good.
Moderately tolerant (ESP = 20-40)	Clover	Stunted growth due to both nutritional factors and adverse soil conditions.
	Oats	
	Tall fescue	
	Rice	
	Dallisgrass	
Tolerant (ESP = 40-60)	Wheat	Stunted growth usually due to adverse physical condition of soil.
	Cotton	
	Alfalfa	
	Barley	
	Tomatoes	
	Beets	
Most tolerant (ESP = more than 60)	Crested and Fairway wheatgrass	Do.
	Tall wheatgrass	
	Rhodes grass	

[1] ESP = exchangeable-sodium-percentage.

Bower, C. A. CHEMICAL AMENDMENTS FOR IMPROVING SODIUM SOILS. U.S. Dept. Agr. Agr. Inform. B. 195, 9 pp. 1959.

Chemical amendments supply soluble calcium for the replacement of sodium attached to soil particles.

Gypsum and sulfur are the chemical amendments most commonly used to improve sodium soils.

Amounts of Various Amendments Required to Supply 1,000 Pounds of Soluble Calcium

Amendment	Purity[1]	Pounds required to supply 1,000 pounds of soluble calcium
	Percent	Pounds
Gypsum ($CaSO_4.2H_2O$)	100	4,300
Sulfur (S)	100	800
Calcium chloride ($CaCl_2.2H_2O$)	100	3,700
Limestone ($CaCO_3$)	100	2,500
Sulfuric acid (H_2SO_4)	95	2,600
Iron sulfate ($FeSO_4.7H_2O$)	100	6,950
Alumimum sulfate ($Al_2(SO_4)_3.18\ H_2O$)	100	5,550
Lime-sulfur solution	24 (expressed as sulfur).[2]	3,350

[1] If the amendment has a purity different from that indicated above, determine the amount needed to supply 1,000 pounds of soluble calcium by dividing the percentage of purity given in the table by the percentage of purity of the material to be applied, and multiply this value by the number of pounds shown in the table. For example, if limestone having a purity of 75 percent is used, the calculation would be: (100 ÷ 75) x 2,500 = 1.33 x 2,500 = 3,330 pounds.

[2] Because lime-sulfur solutions have indefinite chemical compositions, their purity is expressed in terms of sulfur content.

ARS, USDA, Inform. Div., Washington 25, D. C.

Pair, C. H., and Lewis, G. C. CHEMICAL AND INTAKE-RATE CHANGES WITH VARIOUS TREATMENTS ON SEBREE-CHILCOTT SOIL SERIES ASSOCIATION (SLICK SPOTS). Soil Sci. 90: 306-311. 1960.

The proper irrigation of a field having soils with widely varying intake rates is very difficult and expensive, and results in low irrigation efficiencies. This is one of the problems in the irrigated areas of southwestern Idaho and eastern Oregon having Sebree-Chilcott soil series.

Methods of improving the intake rates in the soil were studied. The application of gypsum to Sebree (slick spot) soils increased the intake rate from 0.01 inch per hour to 0.10 inch per hour for a 10-ton-per-acre application and to 0.22 inch per hour where a 20-ton-per-acre application was made. The mixing of the Sebree soil profile to a depth of 4 feet increased the intake rate from 0.01 to 0.42 inch per hour.

Both mixing and the application of gypsum raised the intake rate of the Sebree soil to the level of the associated Chilcott soils and will result in better irrigation of these associated soil types.

Both treatments reduced the exchangeable sodium, but the mixing treatment was the more effective in removing the excess of soluble salts.

SWCRD, ARS, USDA, Boise, Idaho.

Ussery, L. R. SALINITY CONTROL THROUGH TILE DRAINS IN HIDALGO CLAY LOAM. J. Rio Grande Valley Hort. Soc. 14: 200-204. 1960.

A tile drainage system in Hidalgo cl in the Lower Rio Grande Valley of Texas removed 29.5 tons of dissolved salts per acre from the top 6 feet of the soil profile during the first year of operation of the drainage system. The 6-inch concrete drain tile was placed at 6.5 to 7.5 feet below the field surface and spaced 200 feet apart, in the 30-acre field under study. Soil salinity was reduced in the top 3 feet of the soil profile to a level permitting the growth of crops of low salt tolerance. A fluctuating, highly saline water table, previously high enough to restrict crop root development, was lowered to permit leaching of salts from the soil profile by irrigation and high-intensity rainfall.

SWCRD, ARS, USDA, Weslaco, Tex.

Pearson, G. A., and Ayers, A. D. RICE AS A CROP FOR SALT-AFFECTED SOIL IN PROCESS OF RECLAMATION. U.S. Dept. Agr., Agr. Res. Serv. Prod. Res. Rpt. 43, 13 pp. 1960.

Reclamation of salt-affected (saline, sodic, or saline-sodic) soils involves leaching excess salt out of the root zone, (washing it out with water). This usually necessitates ponding water on the surface. Rice, because it tolerates prolonged submergence, can often be grown with profit on soil that is undergoing leaching, if conditions are otherwise suitable for this crop and irrigation water of low salt content is available.

In general, rice is very tolerant of salt during germination but is very sensitive to it during the early seedling stage. It gains tolerance in the tillering stage and during maturation, but is sensitive at the time of flowering. Some varieties appear to tolerate salt better than others.

Soluble salts initially present in the root zone of a soil are moved downward by leaching water. Reduction of soil salinity in the root zone to a level that can be tolerated by plants depends principally on the passage of irrigation water through this zone in amounts sufficient to prevent accumulation of salt. The final salinity status of soil subjected to leaching varies according to the salt content of the irrigation water and the rate of percolation. The time required for reducing soil salinity to a desired level by leaching varies according to the percolation rate and the quantity of water required.

A field that is to be seeded with rice by drilling must have essentially nonsaline soil at the surface. If the seed is to be broadcast in water or immediately before flooding, slight salinity of the surface soil may be tolerated. In Asia, rice is sometimes grown in nonsaline soil in nursery beds and transplanted in saline field soil as 4- to 6- week-old seedlings. Highly saline field soil may require some leaching at the surface before the transplanting.

Rice has a relatively shallow root system. Therefore, it is not necessary to move salts to any great depth in order to grow rice. Continued leaching throughout the rice-growing season, affecting the soil to considerable depths, may make it possible to grow a deep-rooted crop after the rice crop.

Growth of rice is retarded by soil salinity. The grain production is affected much more than the vegetative growth. Rice can produce half its normal grain yield only if the average electrical conductivity of the soil solution during the growing season is 8 millimhos or less per centimeter.

On potentially saline soil, rice is sometimes included in a crop rotation as a means of income during periodic leachings. Such a program may make it possible to grow other crops profitably in alternating periods. In some areas, soils may become saline so quickly that they need continual leaching. In this case, it is impossible to grow any crop except the more salt-tolerant varieties of rice. Extreme salinity makes it impossible to grow any variety of rice profitably.

ARS, USDA, Inform. Div., Washington 25, D. C.

Panin, P. S. CHANGES IN THE PERCOLATION OF SALINE SOILS DURING LEACHING. Soviet Soil Sci. 5: 563-567. May 1959.

Percolation and the gravitational flow of water in the leached layer of a saline soil was studied by use of special soil monoliths. The following conclusions were reached:

1. Observations made of the water intake rate on field monoliths and filled columns and also reports from the literature show that the percolation through the leaching layer of a saline clay soil proceeds with diminishing velocity. When water is periodically applied to the saline soil surface, the gravitational moisture at the beginning of leaching completely drains in 24-31 days; with succeeding leachings the gravitational flow lasts 49-94 days. The percolation rate decreases and the drainage period for the gravitational water lengthens more and more markedly as salts are leached from the soil.
2. The change in percolation takes place depending on the change in water-holding capacity of the saline soil. The experiments showed that the water-holding capacity of soil is not a constant quantity: during desalinization, the more salt is removed from the soil, the more it increases.
3. The leaching of saline soils is accompanied by a decrease in concentration of the soil solution and an increase in the amount of loosely bound water; this covers the soil particles in the form of a film, clogs the fine pores and constricts

the water-conducting ones, at the same time increasing the water-holding capacity of the soil and decreasing its percolation.

4. During the leaching of saline soils initially salts are leached from the upper soil horizons. These first lower the percolation rate which slows down the leaching of the lower-lying soil layers and underlying parent materials. After leaching the upper horizons it is advisable to plow deeply and improve the percolation of the soils.
5. The demonstrated continuous drainage of gravitational moisture shows that when sowing crops on insufficiently leached saline soils, it is expedient to irrigate at an increased rate which exceeds the moisture deficit of the root zone. The excess water will drain and carry away salts into the lower layers of parent materials, into the ground waters, and into drains.

Amer. Inst. Biol. Sci., 2000 P St. N. W., Washington 6, D. C.

Kelsall, D. F., Crockford, R. H., and Davey, E. T. DEVELOPMENT OF A MACHINE FOR THE DISSOLUTION OF GYPSUM. J. Agr. Engin. Res. 5: 355-362. 1960.

An account is given of the development of a machine for the efficient continuous dissolution of commercial gypsum in irrigation water flowing at rates of 1-2 cu. ft./s. Water and gypsum are fed to a centrifugal pump in which some dissolution occurs. The pump delivery passes through a series of hydraulic cyclones acting as centrifugal separators, which produce a major fraction of the water as a combined overflow containing dissolved gypsum and a very small fraction of the water as a final underflow carrying undissolved gypsum, which is recycled via a sump to the suction side of the pump. Dissolution efficiencies in the region of 80% were achieved for water flow rates up to 2 cu. ft./s and gypsum concentrations in excess of 10 milliequivalents per litre.

Commonwealth Sci. and Indus. Res. Organ., Chem. Res. Lab., Melbourne, Australia.

Cover Crops

Britt, C. S. GROW WINTER COVER CROPS. Vee-Gee Messenger 12(4): 4. 1960.

Winter cover crops help in controlling erosion. They also reduce leaching by absorbing nutrients that might otherwise be lost. They are generally considered beneficial to soil tilth, particularly under conditions that permit good growth and development of a good fibrous root system. The value of a cover crop in improving soil tilth is associated more with a good sod rather than with the amount of top growth. Legume cover crops fix nitrogen that is released to the subsequent row crop.

This article is a partial review of 25 years of soil and water loss data that shows that winter covers are beneficial in reducing erosion and runoff when planted early and allowed to make good growth. The earlier the cover is seeded in the fall and the later it is turned under in the spring, the more protection it will give against runoff and erosion. Well-established covers of grass or vetch reduced soil loss even more during the succeeding rowcrop period than during the winter period. This is because most of the storms of high rainfall intensity occur during the summer. Properly managed covers have a beneficial effect over and above the surface protection provided before they are turned.

The research data show that we sometimes increase winter erosion by seeding winter covers. This happens when we turn under crop residues and volunteer grasses and weeds in preparation for a late fall seeding of cover crops and the cover crop provides less soil protection than the residues that were plowed down.

At the Beltsville Research Center, a 10-year study compared different winter cover crops and a no-cover check where tobacco was the row summer crop. Ryegrass alone gave the same quality and low yield of tobacco as no cover. Vetch alone lowered the quality of the tobacco but increased the yield. Highest yields and quality of tobacco followed mixed cover crops of either wheat, rye, or ryegrass mixed with vetch. Late turning of mixed cover crops was better than early turning. It gave larger tobacco yields with quality equal to that obtained with early turning.

In the cover crop studies at Beltsville, the water stability of the soil aggregates was measureably improved by all cover crops with the mixtures of rye-vetch and ryegrass-vetch being highest. Ryegrass alone gave almost as good water stability as the mixtures, but the tobacco yields were low.

The improvement of soil by cover crops is difficult to measure, partly because fertility levels as well as soil physical conditions are modified by cover crops. Productivity is increased in most cases where cover crops will grow well and are a part of good soil management to improve structure and tilth. Their long term effect are, therefore, favorable both on crop yields and erosion control.

SWCRD, ARS, USDA, Beltsville, Md.

Climatic Influences

Riley, J. A., and Grissom, P. H. CLIMATE AND CROPS IN HUMID AREAS. J. Irrig. and Drain. Div., ASCE 86(IR 4): 107-128. 1960.

Climatic influence on crop production goes far beyond the obvious limiting effect of drought or flood and searing heat or freezing cold. Each crop has its own optimum value of the weather variables: precipitation, temperature, sunlight and day-length, humidity, and evaporation. Also, the various farm practices necessary to raise a crop efficiently are greatly influenced by these weather variables. In addition, the weather variables themselves have great variation over the humid area. To evaluate an agricultural procedure, the variation of weather, the crop-weather relationship, and the crop practice-weather relationship must all be considered.

Specific considerations for the engineer engaged in designing procedures for increasing farm efficiency in humid areas include the following: (1) The indications are strong that supplemental irrigation during certain critcal periods of the crop cycle will increase most crop yields, even in humid regions; (2) only a small part of the heat received from the sun is actually put to efficient use, and this large potential power supply might be utilized by modified farm practices; (3) the large moisture supply makes the control of insects, diseases, and weeds, and the techniques of tillage and fertilization of particular importance in humid areas; and (4) the modification of certain phases of the microclimate, temperature, sunlight, and evaporation, has demonstrated spectacular increases in crop efficiency in small areas and awaits the development of procedures for the spread of these modifications over large areas.

Weather Bur., U. S. Dept. Commerce, Stoneville, Miss.

Reimann, L. F. MOUNTAIN TEMPERATURE: DATA FROM THE SAN DIMAS EXPERIMENTAL FOREST. Pacific Southwest Forest and Range Expt. Sta. Misc. Paper 36, 33 pp. 1959.

Reimann, L. F., and Hamilton, E. L. FOUR HUNDRED SIXTY STORMS: DATA FROM THE SAN DIMAS EXPERIMENTAL FOREST. Pacific Southwest Forest and Range Expt. Sta. Misc. Paper 37, 101 pp. 1959.

Temperature and rainfall records for twenty-five years from the San Dimas Experimental Forest are presented. The data, as a long term and complete series, should be useful to workers in the field of water supply and control, plant growth, and climate.

Pacific Southwest Forest and Range Expt. Sta., FS, USDA, Berkeley, Calif.

Striffler, W. D. EFFECTS OF FOREST COVER ON SOIL FREEZING IN NORTHERN LOWER MICHIGAN. Lake States Forest Expt. Sta. Paper 76, 16 pp. 1959.

During the winter of 1957-58 a study was made in northern Lower Michigan to determine the effect of forest conditions upon soil freezing. Four important forest cover conditions were sampled: (1) Northern hardward forest; (2) mixed oak forest; (3) open red pine plantations; and (4) closed red pine plantations. Measurements taken during the winter were: (1) Snow depth and water content; and (2) depth and type of soil frost. In addition, the type and depth of humus were determined for each condition sampled. These measurements substantiate the following observations:

1. Red pine plantations with closed crowns accumulated less snow on the ground and froze to greater depths than any of the other forest conditions studied. Frost encountered in the closed red pine plantations was primarily of the impermeable concrete form. During the spring breakup both snow and frost remained longer in the closed pine plantation than in the other forest types.
2. Young open red pine plantations tend to accumulate slightly greater snow depths than all other cover types. They are not as subject to extensive soil freezing as are the closed pine plantations. Of the frost found in these plots less than half was of the concrete type. Snow remained in the open red pine nearly as long as in the closed plantations.
3. Very little frost was encountered under the oak. Of the frost that was found, granular and honeycomb forms were most common. The scrub oak stands accumulated slightly less snow than adjacent open pine plantings. The snow disappeared from under oak faster than from the other forested types studied.
4. Less frost was encountered under northern hardwoods than under the other cover types. Most of the frost was granular. The northern hardwood stands were intermediate in ability to accumulate snow.

Lake States Expt. Sta., FS, USDA, St. Paul, Minn.

Lull, H. W., and Pierce, R. S. FROST AND FOREST SOIL. In Symposium Hannoversch-Munden Sept. 8-13, 1959. P. 48, International Assoc. Sci. Hydrol., pp. 40-48. 1959.

Average depths of concrete frost and its percentage occurrence in 14 forest-condition classes in the Northeastern States are presented and compared with frost observed in four open-land use conditions. Observations in the various conditions were taken bi-weekly during two winters, 1950-52, in each of six areas ranging in location from central Maine to northern Pennsylvania. Statistical significance of differences in concrete frost depth among forest conditions, among open-land conditions, and between forest and open-land conditions are given. Results are interpreted in light of recent findings on time of soil freezing and thawing in the Northeast, on recent ring infiltrometer tests of concrete frost in forest and open land, and on past observations of surface runoff from frozen soils. The effects of climatological and soil differences between forest and open-land conditions are discussed in respect to frost occurrence and persistence.

Northeastern Forest Expt. Sta., FS, USDA, Upper Darby, Pa.

Torfason, W. E., and Nonnecke, I. L. A STUDY OF THE EFFECTS OF TEMPERATURE AND OTHER FACTORS UPON THE GERMINATION OF VEGETABLE CROPS. III. VEGETABLE VINE CROPS. Canad. J. Plant Sci. 40: 596-606. 1960.

A study was made of the effects of temperature and duration of exposure upon the germination of cucumber, muskmelon, and watermelon seed. Seeds of four varieties of each crop were germinated at controlled temperatures by the rolled-towel method. Muskmelon seed germination was significantly reduced as temperature decreased from 60°F. through 55°, 50°, and 45°F. On the other hand, germination of cucumber and watermelon seed was not significantly altered by temperature. Prolonging the duration of exposure to 15 or 22 days resulted in significant reductions in the germination of watermelons but not of the other crops. The interaction of temperature with duration of exposure caused significant differences in the germination of the three crops. At 45° and 50°F., germination decreased generally as exposure lengthened to 15 days and then increased sharply at 22 days. It is postulated that this increase was the result of temperature conditioning or some similar reaction. At 55° and 60°F., germination increased slightly as exposure increased to 8 or 15 days, followed by a decrease at 22 days. This effect was most pronounced at 60°F., probably due to greater fungal activity at that temperature.

It is concluded that satisfactory germination of the vine crops can be obtained after relatively long exposure to temperatures lower than the previously accepted minima.

Canada Agr. Res. Sta., Lethbridge, Alberta, Canada.

Holekamp, E. R., Hudspeth, E. B., and Ray, L. L. SOIL TEMPERATURE - A GUIDE TO TIMELY COTTON PLANTING. Tex. Agr. Expt. Sta. MP-465, 7 pp. 1961.

A uniform stand of cotton with desirable spacing between plants is imperative for mechanizing cotton production. Since a stand requires precise planting operations, both equipment improvements and planting practices are important. The relatively short growing season on the Texas High Plains emphasizes the need of obtaining a satisfactory stand at the first planting.

Soil temperature is a valuable guide in planting cotton. Good cotton stands more likely will be obtained when the minimum soil temperature at an 8-inch depth averages 60°F. or above for the 10 days preceding planting.

Soil temperatures were observed with cotton plantings during a 7-year period, 1952-58, to determine their value as a guide in finding the optimum time to plant cotton at Substation No. 8, Lubbock, Texas. The data obtained support the following conclusions: (1) Minimum soil temperatures at an 8-inch depth for the 10-day period before planting were useful as a planting guide. (2) Cotton seedlings emerged in 5 to 9 days when the preplanting soil temperatures at 8-inch depths averaged 60°F. or above for 10 days. It took as many as 15 days for the seedlings to emerge when the average soil temperature was below 55°F. (3) The total percentage of seedling emergence was highest when the average minimum soil temperature was in the 60° to 70° F. temperature range and decreased rapidly when temperatures were outside this range. Good stands can be expected with two out of three plantings under these conditions, while in colder soils the odds are one out of five. (4) Using soil temperatures, rather than the currently recommended dates as a planting guide, result in earlier plantings when favorable growing conditions prevail and in later plantings when unfavorable conditions exist. Planting on the basis of soil temperature did not reduce yields in this study. (5) The 7-year average date when minimum soil temperatures at the 8-inch depth averaged 60°F. for the previous 10 days was May 3. The earliest date was April 23 and the latest was May 16. (6) The highest average lint yields were obtained in 5 of the 6 years of study by planting on or after the date the soil temperature reached the recommended average of 60°F. And (7) fiber characteristics were not affected adversely by delaying plantings until the soil reached the recommended 60°F.

Agr. and Mech. Col. Tex., Tex. Agr. Expt. Sta., College Station, Tex.

Edgerton, L. J. STUDIES ON COLD HARDINESS OF PEACH TREES. Cornell U. B. 958, 30 pp. 1960.

Controlled freezing experiments have been carried on during the past 12 years in a study of the cold hardiness of peach flower buds and wood. This has been supplemented by observations and data taken after chance winter freezes that resulted in varying degrees of injury to trees in the test orchard.

The hardiness index, or temperature required to kill 50 percent of the flower buds, was determined from controlled-freezing data for Halehaven compiled during this period. For each season this index of bud hardiness was plotted with the daily mean temperatures to show the fluctuations in hardiness in relation to temperature trends.

The flower buds increase in hardiness rapidly with the cooler temperatures of the fall and early winter. Maximum hardiness for the winter occasionally coincided with the end of the rest period, which occurs about January 1, at Ithaca, but this varied with continued cold temperature. In two years, maximum hardiness was reached after the middle of February.

Fluctuations in the cold hardiness were more frequent and extensive after the rest period ended early in January. The reason for this is that three or four days of mild temperature while the buds are in rest result in little, if any, loss in hardiness, but similar conditions after the rest period can cause appreciable loss in hardiness. Buds usually regained hardiness with succeeding periods of cold weather. This loss and gain of hardiness occurred periodically until the buds were advanced to the pink stage in the spring. In spite of the frequent periods when a warming trend during the winter caused loss in hardiness, a return to seasonal temperatures prevented extensive bud activity. Once the hardiness index for Halehaven index dropped below -4°F. in late fall, it did not rise above this point until there was visible swelling of the buds in the early spring.

This fluctuation in hardiness while the buds were still dormant was of such magnitude that maximum hardiness developed during a prolonged cold period in January 1948, and 15 percent of the Halehaven buds survived -19°F. Two years later when above-normal temperatures prevailed during January, only moderate hardiness was attained and a temperature of -8°F. in February killed about the same percentage of buds on these same trees.

The effect of several orchard practices on bud hardiness was investigated. A reduction in fruit set by the use of chemical thinning sprays increased bud hardiness the following winter.

Moderate differences in the level of nitrogen fertilization had little effect on peach bud hardiness. The effect of cultivation was compared with different cover-cropping practices and, likewise, no significant effects on bud hardiness were detected within the levels of tree vigor obtained in these tests.

Studies on cold hardiness of the woody tissues indicated much slower development of hardiness in the wood than in the flower buds. It was usually not until early December, that the twigs became more resistant to low temperature injury than the flower buds, but from that time on, the bark, cambium, and sapwood of twigs and main branches were generally more hardy than flower buds.

Chemical thinning was found to promote wood hardiness during the subsequent winter. A nitrogen status high enough to cause excessive vegetative growth in a tree also hindered development of hardiness, but of wood more than bud hardiness.

Early winter pruning had a marked effect on susceptibility to cold injury in both twigs and main branches.

Cornell U. Agr. Expt. Sta., N. Y. State Col. Agr., Ithaca, N. Y.

Jordan, H. V., Bardsley, C. E., Jr., Ensminger, L. E., and Lutz, J. A., Jr. SULFUR CONTENT OF RAINWATER AND ATMOSPHERE IN SOUTHERN STATES: AS RELATED TO CROP NEEDS. U.S. Dept. Agr. Tech. B. 1196, 16 pp. 1959.

Rainwater was collected at 109 locations in the Southern United States and was analyzed for sulfur during the 3-year period, 1953-55. Rainwater collected in Virginia, Kentucky, and Tennessee was found to contain more sulfur than did that from the other States included in the investigations--Alabama, Arkansas, Florida, Georgia, Louisiana, Mississippi, North Carolina, South Carolina, and Texas. In those nine States, a few locations had high sulfur-accretion values because of their proximity to industrial establishments. In the rural areas of the nine States, average accretions of sulfur in rainwater were 5.8, 4.1, and 6.3 lbs. per acre in 1953, 1954, and 1955, respectively. The general average for the 3 years was 5.4 lbs. per acre.

The principal source of sulfur in atmosphere and rainwater, especially in the winter months, is the discharge of combustion gases from burning coal and wood. Seasonal variations in the sulfur content of rainwater are small.

Sulfur in rainwater makes only a minor contribution to the sulfur required by crops in the nine cooperating Southern States other than Virginia, Kentucky, and Tennessee.

Sulfur in the atmosphere was measured at 8 locations in Alabama and at 19 locations in Virginia. As in rainwater, sulfur in the atmosphere was generally found to be higher at the Virginia locations.

Crops commonly grown in the Southeast, such as clover, alfalfa, and cotton, require from 15 to 25 lbs. of sulfur per acre for normal production. Vegetable crops of the Cruciferae and Liliaceae families have even higher sulfur requirements. Corn and grasses require 10 lbs. per acre or less.

Surface soils in the Southeast characteristically contain 3 p.p.m. (6 lbs. per acre) of extractable sulfur or less, although there are accumulations of larger amounts in lower soil horizons. Such soils are potentially deficient in sulfur. Production has probably been maintained on many of these soils by incidental additions of sulfur in fertilizers and rainwater and, to some extent, by direct uptake of atmospheric sulfur by soils and plants.

This study emphasizes the importance of soil-management practices that include additions of sulfur in fertilizer or other amendments in the nine Southern States mentioned. A planned program of sulfur applications should replace dependence on incidental additions.

ARS, USDA, Inform. Div., Washington 25, D.C.

Hendricks, S. B. RATES OF CHANGE OF PHYTOCHROME AS AN ESSENTIAL FACTOR DETERMINING PHOTOPERIODISM IN PLANTS. Cold Springs Harbor Symposia on Quantitative Biology 25: 245-248. 1960.

The time dependence of change in darkness of the two known forms of phytochrome, the active principle of photoperiodism in plants, is discussed in its relation to photoperiodic induction of flowering.

Mineral Nutr. Lab., SWCRD, ARS, USDA, Beltsville, Md.

Ashby, W. C., and Hellmers, H. FLOWERING AND GROWTH RESPONSES TO PHOTOPERIOD AND TEMPERATURE FOR SIX SOUTHERN CALIFORNIA GRASSES. Bot. Gazette 120 (3): 151-157. 1959.

Growth and flowering responses to temperature and photoperiod were studied for six grasses that grow in the San Gabriel Mountains of southern California. The grasses included a native annual or short-lived perennial, California brome (Bromus carinatus Hook. and Arn.); two resident annuals, ripgut (Bromus rigidus Roth) and foxtail chess (Bromus rubens L.), both introduced from the Mediterranean area; three native perennials, California melic (Melica imperfecta Trin.), foothill needlegrass (Stipa lepida Hitch.), and pine bluegrass (Poa scabrella (Thurb.) Benth. ex Vasey). The results were as follows: (1) All species grew well at 20°C. day with 3°, 6°, or 10°C. night temperatures. A 30°C. day with a 3°C. night restricted the growth of several species. (2) The flowering of California brome was little affected by photoperiod. (3) The resident annuals (ripgut and foxtail chess) and two native perennials (California medic and foothill needlegrass) flowered 10-20 weeks earlier under a 24-hour than under an 8-hour photoperiod. (4) Pine bluegrass flowered only under the 8-hour photoperiod and then only after 24 weeks when kept at constant daylength. And (5) in a second series of experiments, California melic and pine bluegrass could be made to flower simultaneously. After the seed of both species had been germinated and the plants grown under an 8-hour photoperiod for 3 months, they were transferred to a 16-hour photoperiod, where they flowered in 5-6 weeks.

Calif. Inst. Tech., and Calif. Forest and Range Expt. Sta., FS, USDA, Berkeley, Calif.

Oebker, N. F., and Courter, J. W. GROWERS TRY PAPER MULCH. Amer. Vegetable Grower. 8(5): 18-19. 1960.

The newest innovation being tried by growers in Illinois is a fungicide-treated paper for mulching vegetables. In 1959, the department of horticulture of University of Illinois conducted tests with the new mulch on commercial vegetable acreage in the Prairie State.

Paper mulch offers many of the same benefits as black plastic mulch. It controls weeds in the row, conserves moisture, keeps fruits clean, helps prevent fruit rots, warms soil in spring, prevents leaching of nutrients, and maintains good physical condition of the soil. All of these benefits contribute to earlier crops, bigger yields, and better quality.

Paper has two big advantages over plastic mulch--lower cost and no disposal problem. A 40-lb. black paper 40 inches wide will be available this year which will cost about $100 per acre (6-foot row spacing) compared to $120 to $140 for 1.5 mil plastic. Unlike plastic which must be removed, paper can be plowed under without interfering with the following crop.

Chief disadvantage of paper is that it tears easily. However, this problem can be overcome if a good seedbed is prepared (large stones, clumps of sod, and lumps of soil puncture paper and clog plows of laying machine) and if the paper is laid carefully.

The paper mulch used in the 1959 tests was a brown kraft-type treated with a fungicide to prevent it from decomposing during the growing season. Several different weights were used.

The biggest drawback when using a mulch such as paper or plastic is the hand planting of seeds or transplanting through the mulch. The normal process is to cut holes in the paper at the desired distances apart and to place the seed or plant in the soil at these points. A desirable and workable spacing between rows for tomatoes and cucumbers when using paper mulch was found to be 6 feet.

Hoeing and cultivating are reduced considerably with paper mulching. With vine crops only a little hand weeding may be needed around the plants at thinning time. Weeds are seldom a problem around transplants. Some cultivation is needed in the area between rows.

Preliminary studies show that black mulching materials of paper or plastic when exposed to sunlight increase the soil temperature. This is an advantage in the spring but in midsummer high soil temperatures are often undesirable because they reduce root growth, resulting in decreased yields. To avoid this problem good foliage growth should be encouraged.

No farm yield records were kept in 1959 but experiments in 1958 showed significant increases in yield from mulching both tomatoes and cucumbers. They gave over 90% increase in both early and total yield when mulched.

U. Ill., Urbana, Ill.

Clarkson, V. A. PLASTIC MULCH PAYS . . . IF PROPERLY APPLIED. Amer. Veg. Grower 8(4): 30-31. 1960.

Increased and earlier yields of many vegetables and fruits are possible through the use of black polyethylene mulch. This has been proved in many tests by State and USDA agriculturalists and commercial growers throughout the United States. Melons, cucumbers, beans, tomatoes, lettuce, and many other crops have responded well to plastic mulch--when it is properly applied.

Results of two-year tests at Union Carbide's Research Farm in North Carolina show that several factors that influence plant growth can be controlled by plastic mulch. The control of most weeds that compete with plants for soil moisture and nutrients, results in more vigorous crop growth. The effective barrier afforded by the mulch between the ripening fruit and soil, which often is contaminated with fruit-rotting organisms, resulted in a significant decrease in rotted fruit and generally cleaner fruit.

Estimating that from one-half to two-thirds of each acre is to be covered, total cost of $1\frac{1}{2}$ mil black polyethylene film will range between $95 to $125 an acre, depending on the local cost of film and the quantity purchased. Machine laying will cost less than $5 an acre.

Based on daily Raleigh market prices, the total cash value for mulched slicing cucumbers in the 1958 studies was $1267, and for the unmulched, $536.

The following suggestions, based on research by the author and others, will help to minimize improper usage and to increase yields:
(1) Use plants adopted to the area. (2) With 4-foot row spacing use 3-foot wide plastic; with 5-foot row spacing use 4-foot wide plastic. This leaves enough room between strips to bury the edges and allow water penetration. (3) Bury film edges at least 2 to 3 inches deep. (4) With adequate irrigation, planting on a raised bed or ridge is superior to planting in a flat row. In arid areas with furrow irrigation, it may be necessary to leave the furrow uncovered for water penetration. With sprinkler irrigation, water penetration in the uncovered areas and through holes around the plant is usually sufficient. (5) Provide adequate moisture for seed germination and transplant survival by irrigation prior to mulching if needed. Irrigate immediately after transplanting. Plant seeded crops through the mulch, using a hand corn planter or similar instrument. Transplant through a hole cut in the mulch. A machine is being developed which will both plant and transplant directly through mulch at commercial speeds. (6) Follow recommended fertilizer applications for your area and crop. Additional nitrogen fertilizer is not usually needed during the growing season since plastic mulches are effective in reducing nitrogen losses from leaching. Overfertilization may result in decreased yields. (7) The surface temperature of the plastic and air temperature above the mulch may be much higher than the soil surface temperatures. Therefore, transplanting during hot weather is not recommended. (8) Weed control between plastic strips can be effected by shallow cultivation or chemical weed control. (9) Black $1\frac{1}{2}$ mil polyethylene is best for overall service. (10) Purchase only high quality film from recognized dealers and manufacturers, as inferior film often deteriorates prematurely. And (11) do not mulch your entire field the first time. Try the plastic on a limited scale and see the results. Become acquainted with its advantages and limitations--then decide for yourself.

Union Carbide Research Farm, Clayton, N. C.

Waggoner, P. E., Miller, P. M., and De Roo, H. C. PLASTIC MULCHING: PRINCIPLES AND BENEFITS. Conn. Agr. Expt. Sta. B. 634, 44 pp. 1960.

A technical study of the effects of plastic mulch compared with other mulches on soil climate, soil temperatures, evaporation, and leaching of nutrients.

The effects of plastic mulch are also studied on strawberry and tobacco crops in the field.

Conn. Agr. Expt. Sta., New Haven, Conn.

Chepil, W. S., Woodruff, N. P., Siddoway, F. H., and Lyles, L. ANCHORING VEGETATIVE MULCHES. Agr. Engin. 41: 754-755, 759. 1960.

The most effective methods and equipment to anchor vegetative mulches to stabilize soils against wind erosion was studied. A plot of land was seeded to grass and fertilized and various quantities, of mulch in the form of hauled-in prairie hay and wheat straw were applied uniformly on the surface using a blower type mulch spreader. Five different types of mechanical packers (cutaway rolling disk packer, smooth rolling disk packer, V-tread rolling wheel packer, plate punch packer, and an L-rod punch packer) and various quantities of asphalt emulsion and cutback were used to anchor the mulch.

During the tests the best implement for anchoring mulch was a disk packer, preferably with cutaway disks spaced not more than 4 in. apart if penetration and clogging are not a problem, as on dune sand. Where penetration or clogging is a problem, disks have to be spaced about 8 in. apart for packing once, or 12 in. apart for packing once in one direction and then once in the direction perpendicular to the first packing to form a grid system of rows.

The disks should penetrate at least 2 in. but not more than 3 in. for proper anchorage and effectiveness. If ground is too hard for disks to penetrate to proper depth, it should be loosened by tillage to the depth of desired disk penetration.

The average quantity of well anchored (packed) mulch required for adequate protection against equivalent 85-mph wind appears to be as follows:

6000 lb. per acre of wheat straw on most erodible dune sand.

5000 lb. per acre of prairie hay on most erodible dune sand.

5000 lb. per acre wheat straw on less erodible soils.

4000 lb. per acre of prairie hay on less erodible soils.

When a packer cannot be used, such as on steep dunes or construction slopes, liquid asphalt mixed with the mulch can be applied. For mulch anchored with asphalt on smooth ground and any degree of soil erodibility, including dune sand, the following treatment appears to be fully effective against strong winds: a uniform cover of 4000 lb. per acre of prairie hay or 5000 to 6000 lb. per acre of wheat straw mixed thoroughly with a fine spray of at least 300 gal. per ton (600 gal. per acre) of rapid-curing-asphalt cutback (RC) or emulsion for hay or with at least 400-gal. per ton (900 to 1000 gal. per acre) of rapid-curing-asphalt cutback or emulsion for straw.

For mulch anchored with asphalt on moderately rough ground of any degree of erodibility, the same quantity of mulch as for smooth ground can be used but the quantity of asphalt can be reduced to 200 gal. per ton (400 gal. per acre) for hay and 300 gal. per ton (700 to 900 gal. per acre) for straw.

Complete effectiveness of mulching and anchoring the mulch without packing apparently consists of (1) complete cover of the ground with the mulch, and (2) adequate anchorage of the individual pieces of the mulch to the ground or to each other. On loose sand, little anchorage of the mulch to the ground occurs so that the stability of the mulch cover depends on the roughness of the ground and on the strength with which the individual pieces of the mulch are held together by the cementing agent. The ground roughness should not exceed 4 in. in height.

SWCRD, ARS, USDA, Manhattan, Kans.

Smith, W. L. MULCHING FLOOD PREVENTION STRUCTURES. Soil Conserv. 26:38-39. 1960.

Mulching flood prevention structures with grass hay to protect the slopes and speed up the establishment of grass cover is a common practice in Texas.

Structures on which grass is established by dryland seeding are mulched prior to seeding. Where grass cover is established by planting vegetative parts of plants such as bermudagrass rhizomes, mulching is not required.

Prairiegrass, marshgrass, Medio bluestem, King Ranch bluestem, and Buffelgrass hays have been the most successful for mulching. Johnsongrass, sorghums, and small grain straws are too brittle for anchoring and usually produce a crop of weeds and grain competitive with the grass seedlings. Mulch hay must be durable, with at least 50% of the hay 10 inches in length or longer. Most hay lasts a minimum of one year before decomposing. In areas of lower rainfall and without fertilizer, the mulch lasts longer. Marshgrass hay has lasted four years in some of the drier areas.

The rate of hay mulch usually is about $2\frac{1}{2}$ tons per acre, where anchored. If held in place by strings or netting, $1\frac{1}{2}$ to 2 tons per acre is adequate. Apply just enough mulch to control erosion and not inhibit the germination of the seed and growth of the grass seedlings.

A good seedbed, free of clods and stones, prepared to a depth of 3 to 4 inches, is necessary so the hay can be anchored into the soil. A tillage tool followed by disking will, in most cases, prepare a good seedbed. The seedbed should be firm underneath the 3- to 4-inch prepared depth. Breaking with a moldboard or dryland disk plow would normally prepare a seedbed too deep and loose for planting grass.

The hay is spread uniformly over the area to be seeded, usually by hand.

Immediately after the mulch is spread it is anchored by tucking it into the soil with a mulch tiller tool.

The structures usually are mulched as soon after construction as possible, regardless of the season of the year. This may be immediately preceding the seeding or as much as 8 months before seeding. The seeding is timed so as to plant only during the optimum planting time for the grasses.

The grass seed is drilled directly into the anchored mulch with as little disturbance to the mulch as possible. A cultipacker drill is used if the seedbed has not been firmed by rain.

The mulch prevents rilling, sheet erosion, and crusting of the soil surface on the dam. It speeds germination of the grass seed and the artificial cover conserves moisture and lowers soil temperature, which helps the small seedlings to survive during hot, dry summer months.

SCS, USDA, Denton, Tex.

Pruett, E. MULCH AROUND NEWLY PLANTED TREES CAN BE DETRIMENTAL. Central States Forest Expt. Sta. Note 132, 2 pp. 1959.

Mulching is generally regarded as helpful to survival and growth of planted trees. However, a recent test in Iowa revealed that under certain conditions mulching may be harmful. In an experimental plantation containing 10 species, twice as many mulched seedlings died the first year as unmulched.

The trees were planted in an old cornfield in $\frac{1}{2}$-acre plots, one species to a plot. One row of each species was mulched with sawdust and the remaining rows in the plot were not mulched. Approximately 1.5 cubic feet of sawdust was placed in a 3-foot circle around each seedling. During the following growing season, weed development was exceptionally vigorous and dense on the fertile soils of this area, with patches of giant ragweed and wild hemp reaching heights of 5 feet and more. Although the sawdust mulch effectively prevented weed growth on the treated spots, the seedlings were still heavily shaded by a canopy formed from the tall and overtopping vegetation. Survival of most species at the end of 1 year was lower in mulched than unmulched rows:

	Mulched trees	Unmulched trees
	(In percent)	(In percent)
Austrian pine	53	70
Eastern white pine	54	78
European larch	52	26
Norway spruce	4	82
Black walnut	100	100
Cottonwood	80	76
Green ash	4	80
Hybrid poplar	32	70
Red oak	0	59
Yellow-poplar	14	62
All species	40	70

This difference in survival was caused by heavier rabbit injury to mulched trees. Apparently the openings created under the weed cover by mulching were conspicuous and attractive to the many rabbits in the area. It can probably be assumed that any treatment which would result in such openings around the base of small trees would also result in increased rabbit-caused mortality.

Central State Forest Expt. Sta., FS, USDA, Columbus, Ohio.

PLANT MANAGEMENT

Pasture and Hayland

McGinnies, W. J. EFFECT OF MIMA-TYPE MICRORELIEF ON HERBAGE PRODUCTION OF FIVE SEEDED GRASSES IN WESTERN COLORADO. J. Range Mangt. 13: 231-234. 1960.

Mima-type microrelief has been commonly observed in the treeless areas of the western United States. This microrelief is characterized by low mounds or soil pimples, commonly called "Mima mounds" after the Mima Prairie in western Washington. Some contend that the Mima mounds are a result of physical actions of ice wedges and erosion while others feel that the mounds are built largely by the activity of fossorial rodents such as pocket gophers or prairie dogs. Present evidence tends to favor the formation of the mounds by rodents in Colorado and adjacent areas. The subsoil in mounded areas usually contains a cemented hardpan, bedrock, gravel bed, or water table, which limits root growth and the activity of fossorial rodents. In Colorado, the mounds vary in height from less than a foot to several feet and in diameter from 15 to 25 feet; the diameter is approximately equal to the territory of a pocket gopher.

Mima-type microrelief and its influence on herbage yields in western Colorado have been described. An area on the Uncompahgre Plateau with typical

Mima mounds was seeded to intermediate and crested wheatgrasses, smooth brome, Russian wildrye, and big bluegrass in 1949-53. In 1959, yield determinations and stand evaluations were made on the mounds and between the mounds to determine the effects of microrelief on the seeded species.

Herbage yields on the Mima mounds were 94 percent (intermediate wheatgrass) to 542 percent (big bluegrass) greater than between the mounds. Stands were better on the mounds by 29 percent (Russian wildrye) to 183 percent (smooth brome). Nitrogen, as estimated from organic matter, was 66 percent greater on the mounds than in the intermound areas. Although water-holding capacity was about the same for both locations, the depth of soil above bedrock was twice as great in the mounds as between the mounds, allowing greater volume of water to be stored in the mounds.

It is suggested that the higher yields on top of the mounds result from a combination of better stands, more nitrogen, and a greater soil volume available for water storage.

CRD, ARS, USDA, Fort Collins, Colo.

Schmidt, D. R., and Tenpas, G. H. A COMPARISON OF THE PERFORMANCE OF BROMEGRASS, ORCHARDGRASS, AND TIMOTHY IN NORTHERN WISCONSIN. Agron. J. 52: 689-691. 1960.

Bromegrass, orchardgrass, and timothy grown in two legume associations and in two fertilizer treatments were cut at hay and pasture stages in northern Wisconsin. No grass species was best in all associations and under all cutting treatments. Timothy produced the most dry matter in pure stands without nitrogen fertilizer and in association with trefoil-red clover. Orchardgrass was the most productive when fertilized with nitrogen and cut at the pasture stage. Because of its vigor, orchardgrass was too competitive for associated legumes reducing the total yield of the association. Bromegrass yields were slightly higher than those of timothy and orchardgrass in the alfalfa-ladino association under both cutting treatments and in nitrogen-fertilized stands managed as hay.

Crude protein production was usually in the following order: bromegrass, timothy, and orchardgrass. Timothy was somewhat less persistent than bromegrass or orchardgrass.

Ashland Branch Expt. Sta., Wisc. Agr. Expt. Sta., Ashland, Wisc.

Hull, A. C., Jr. WINTER GERMINATION OF INTERMEDIATE WHEATGRASS ON MOUNTAIN LANDS. J. Range Mangt. 13: 257-260. 1960.

Intermediate wheatgrass seed in cotton mesh bags was covered with soil $\frac{1}{2}$ inch deep on September 14 and November 2, 1957. Some of the bags were removed once a month to July 1 so that germination of seed could be checked. Seed put in the ground on September 14 had germinated 89 percent by November 2. The field germination remained between 89 and 91 percent until July 1. Seed put in frozen ground under 5 inches of snow on November 2 germinated 35 percent by February 1. Field germination increased each month to 78 percent on May 1 and remained between 73 and 78 percent until July 1.

Thermometers and a thermograph bulb $\frac{1}{2}$ inch deep in the soil under the snow during March, April, and May gave a temperature range from 31 to 35°F. Melting of the frozen soil during November also indicated that soil temperatures were above freezing during November. This study showed that slightly above freezing temperatures under the snow was adequate for germination of intermediate wheatgrass seed.

CRD, ARS, USDA, Logan, Utah.

Hoveland, C. S. BERMUDAGRASS FOR FORAGE IN ALABAMA. Ala. Agr. Expt. Sta. B. 328, 22 pp. 1960.

The origin of Bermudagrass (Cynodon dactylon) is obscure, but it probably is a native of Africa. It was introduced into the United States prior to the middle 1700's. Over the years it earned a reputation as a serious pest in cultivated crops.

With increasing emphasis on livestock production in Alabama and introduction of improved varieties, Bermudagrass has assumed a new importance. Because of its vigor and productivity, Bermudagrass is now considered a valuable plant for forage production.

Bermudagrass is a rapidly spreading perennial, having both underground and aboveground creeping stems. It is a hot weather plant, making little growth when night temperatures drop below 50° F. Temperatures of 26 to 28° F. usually kill the herbage back to the ground. Drought tolerance of Bermudagrass is much better than that of Bahiagrass, carpetgrass, or Dallisgrass.

Bermudagrass is best adapted to moderately well-drained soils with medium to high fertility. It will tolerate considerable flooding, but makes little growth under these conditions. When adequate nutrients are available, it grows well at soil reactions ranging from pH 5.0 to 8.0.

Common Bermudagrass, a vigorous perennial warm season grass, varies widely in plant characteristics, depending on the ecotype. None of the local Bermudagrass ecotypes in Alabama has equalled Coastal in production.

Coastal, a hybrid, is cold hardy enough for the entire State and has generally given forage yields equal to or better than other species tested. Hay yields of over 8 tons per acre have been obtained. It is not adapted to conditions of poor drainage.

Higher steer gains per acre have been achieved with Coastal Bermudagrass than with other perennial warm season grasses tested. However, daily gains per animal have not been high unless a winter legume was grown with the grass. Satisfactory results have been obtained with brood cows and calves on Coastal Bermudagrass and clover or vetch. Coastal Bermudagrass has failed to maintain a high level of lactation for high producing dairy cows when used as the sole source of roughage.

Growing a winter legume on Coastal Bermudagrass sod has extended the grazing season, increased forage yield, and improved animal performance.

Midland Bermudagrass has given high forage yields but has shown no superiority over Coastal. Suwanee is difficult to establish and not cold hardy enough except in southern Alabama. Greenfield and NK-37 are inferior to Coastal and Midland.

Agr. Expt. Sta., Auburn U., Auburn, Ala.

Oliver, J. H. QUALITY CONTROL IN HAY MAKING. Agr. Engin. 41: 748-750, 761. 1960.

A review of the literature on making high quality hay. Various charts and tables are presented to show the farmer, with facts and figures, how much it will pay him to change his haying practices.

There is no surplus of early-cut quality hay in either farmer or government storage, nor is there any quota or other limitation on the production of this valuable crop. Farmers who plan to stay in business producing milk, beef, or sheep need better roughage to reduce production costs or they may not survive in these times with prices dictated by large surpluses.

The hay drier, along with the hay conditioner, opens the way to putting up quality hay every day the sun shines during the haying season. No more waiting for two or three good days in a row to field-cure hay and no need to put it up as grass silage either. Every farmer needs drying equipment now to dry hay, corn, small grains, rice, peanuts, or beans. It will generally produce a 100 percent return on the investment each year it is used.

The purchase of drying equipment to dry all crops can be one of the most profitable investments a farmer can make and to some it may mean the difference between operating at a profit instead of a loss.

Aerovent Fan and Equipment, Inc., Lansing, Mich.

Lodge, R. W. EFFECTS OF BURNING, CULTIVATING, AND MOWING ON THE YIELD AND CONSUMPTION OF CRESTED WHEATGRASS. J. Range Mangt. 13: 318-321. 1960.

The effects of renovation treatments, cultivating, mowing, and fall and spring burning on the forage yield and consumption by sheep of crested wheatgrass were examined during and after two spring grazing seasons. The basal area of the cover and its floristic composition were not, in the long run, affected by any of the treatments. All treatments reduced forage yield in the first year. Consumption by sheep in the two-year period after fall burning and mowing was not reduced. Spring burning reduced both forage yield and consumption by sheep.

Canada Dept. Agr., Swift Current, Saskatchewan, Canada.

Boddy, H. ALTERNATE-ROW SEEDING OF GRASSES AND LEGUMES. Soil Conserv. 26: 89-91. 1960.

More and more Pacific Coast dairymen like the results they're getting from alternate-row seedings of grasses and legumes. The alternate-row technique holds real promise for pasture builders whose old broadcast seedings and mixed seed drillings haven't paid off too well.

Some legumes and grasses grow well together and some don't. Alternate-row seeding means that hard-to-start legumes and those that don't compete too well with grasses grow in their own row. Given more space, legumes get off to a good start and keep on growing right beside neighboring rows of grass.

Washington and Oregon farmers who use alternate-row seedings say the method turns out more feed, hay, humus, and fertility plus a better balanced ration for cows.

Milk and butterfat yields of many dairy herds dip and waver when legumes fail to keep up with faster growing, take-over grasses. When birdsfoot trefoil is seeded with grass, poor stands often result. And when trefoil is seeded alone, weeds and weedy grasses are the rule. The same is true of legumes like alfalfa.

So far about 100 successful alternate-row seedings have been made in 35 soil conservation districts in western Oregon and Washington.

Alternate-row seedings take a bit more time and effort than other seedings. But the way some of the first farmers to use this technique have continued to plow out old pastures and put their stake in alternate rows is a pretty good sign that they are a good bet for hay and pasture.

SCS, USDA, Berkeley, Calif.

Youngman, V. E., and Patterson, J. K. CAN FERTILIZERS EFFECTIVELY INCREASE OUR RANGE LAND PRODUCTION? J. Range Mangt. 13: 255-257. 1960.

The recent widespread use of nitrogen fertilizer for wheat production in the Northwest has interested ranchers in the possibilities of using nitrogen to increase forage production on their adjoining ranges.

In Washington the soils are relatively high in phosphate. The main problem then is to determine the response that can be expected from the application of nitrogen to native or reseeded ranges. Ranges in central Washington have become infested with an introduced grass, cheatgrass (*Bromus tectorum*). It appears unwise to stimulate its production at the expense of our more desirable indigenous perennial species.

The data in Table 1 show the response that can be obtained by adding nitrogen fertilizer to native range in an annual rainfall area of 12 to 13 inches. The native grass species there made good use of the nitrogen at rates up to 40 lbs. of N per acre since the production was doubled. The naturalized cheatgrass production increased from an average of 6 percent (1956) to 13 percent (1957), where no fertilizer was applied, compared to 19 percent (1956) to 58 percent (1957) where 40 lbs. of N were supplied. Increased rates of nitrogen aided the cheatgrass at the expense of the native grasses as can be seen in Table 2.

TABLE 1.--Oven dry herbage (*Poa, Festuca and Agropyron spp.*) produced on native grasslands with differential rates of nitrogen application at Hooper, Washington. 1953-1957.

Nitrogen (pounds) applied per acre	1953	1954	1955	1956	1957	Av.	Pounds herbage per pound N added
			Pounds per acre				
0	410	430	330	860	660	538	
20	580	780	640	1280	1040	864	16.
40	1080	940	640	1550	1240	1090	11.5
60	970	840	700	890	690	818	-12.5
80	1190	940	660	730	720	848	0.5
Average	850	780	590	1060	870	832	

TABLE 2.--Oven dry herbage produced by four grass species on native grassland under differential rates of nitrogen application at Hooper, Washington. 1956.

Nitrogen pounds per acre	Agropyron inerme	Festuca idahoensis	Poa secunda	Bromus tectorum	Total	Percent Bromus tectorum
			Pounds per acre			
0	708	58	93	57	916	6
20	864	266	150	168	1448	12
40	1161	125	263	370	1919	19
60	621	42	224	443	1330	33
80	468	27	239	283	1017	28
Average	764	104	194	264	1326	20

Nitrogen response of seeded crested wheatgrass (*Agropyron desertorum*) (Table 3), promised even more hope for possible commercial application of fertilizer to range areas. The yield of crested wheatgrass was doubled by the use of 40 lbs. of N. Furthermore, crested wheatgrass can utilize increased rates of fertilizer up to 80 lbs. of N with substantial increases in production. It

TABLE 3.--Fertilizer response of crested wheatgrass, oven-dry hergage per acre, Hooper, Washington

Nitrogen applied per acre	1953	1954	1955	1956	1957	5-yr. av.	Herbage per pound added N
			Pounds Per Acre				
0	2130	1050	850	1120	970	1220	
20	2680	1450	1180	1150	990	1490	13.5
40	3350	2160	1870	2550	1590	2300	40.5
60	4020	2390	1780	3420	2040	2730	21.5
80	4180	2570	1310	3680	3050	2960	11.5
Average	3270	1920	1400	2380	1730	2140	

should be noted that the doubling of production of crested wheatgrass with 40 lbs. of N resulted in about 1100 lbs. gain in yield--the native grasses doubled their yield at the same rate of nitrogen but produced only 550 lbs. of additional herbage.

Under present costs and prices it would seem that only the rancher in areas receiving at least 13 inches of precipitation annually with crested wheatgrass range would benefit by nitrogen fertilizer application. A few more might use nitrogen fertilization to provide increased growth on a part of the range for early grazing to cut down winter feeding costs.

Wash. State U., Pullman, Wash.

Bradshaw, A. D., Chadwick, M J., Jowett, D., Lodge, R. W., and Snaydon, R. W. EXPERIMENTAL INVESTIGATIONS INTO THE MINERAL NUTRITION OF SEVERAL GRASS SPECIES: PART III. PHOSPHATE LEVEL. J. Ecol. 48: 631-637. 1960.

The reaction of eight grass species to variation in phosphate concentration was studied in sand culture and summarized as follows: (1) The species show different yield reactions to variation in phosphate. *Lolium perenne*, *Agrostis stolonifera*, *A. tenuis* (normal) showed marked increases in growth with increases in phosphate while *A. tenuis* (lead-resistant ecotype), *Cynosurus cristatus*, *Festuca ovina* and *Nardus stricta* showed little or no increase with the phosphate levels used. *Agrostis canina* gave an uncertain response. This grouping must be considered to be an over-simplification since there were differences between the reactions of almost all species. (2) These reactions were not necessarily parallel to those shown previously in relation to variation in calcium level. And (3) a comparison of these results with previously published field observations confirms their validity and suggest that soil phosphate levels are an important factor in determining the distribution of species.

U. Col. of North Wales, Bangor, North Wales.

Haddock, J. L. THE INFLUENCE OF RESIDUAL NITROGEN AND PHOSPHORUS FERTILIZER ON THE YIELD AND CHEMICAL COMPOSITION OF ALFALFA. Proc., Eleventh Annual Fert. Conf. Pacific Northwest, Salt Lake City, Utah, July 13-15, 1960. pp. 89-98. 1960.

Nitrogen exerts a small unfavorable residual influence on alfalfa yields for one or two years after application. Under some conditions it manifests an unfavorable direct or indirect influence on alfalfa seed production two and three years after application. The residual influence of moderate applications of nitrogen fertilizer on chemical composition of alfalfa after one year, is extremely small.

The residual effects of small applications of phosphorus fertilizers are easily detected after three and four years. This influence is most prominently observed in yield of alfalfa hay and in phosphorus concentration of alfalfa forage. But it frequently manifests its effect by reducing the potassium concentration of alfalfa hay.

Under moderately high levels of available soil phosphorus, alfalfa seed yields are significantly reduced by additional phosphorus fertilizers. One possible explanation for this reduction is the relative unbalance of K:P in the alfalfa plant. High available soil phosphorus and high concentrations of phosphorus in plant tissue are associated inversely with dry matter in the alfalfa plant under some conditions. Where alfalfa seed is to be grown, the phosphorus level should be 18 to 25 pounds per acre six inches.

The recommended level of sodium bicarbonate soil phosphorus should be raised from 22 to 35 pounds per acre six inches of soil for alfalfa hay unless available subsoil phosphorus has been shown to be relatively high.

While much progress has been made in developing adequate soil tests which serve as a guide to proper fertilization of the alfalfa crop, additional work is needed in the interpretation of these tests.

The critical levels suggested for phosphorus content of alfalfa need clarification. Under what specific conditions are 17.4, 21.3, and 26.1 m.e. per 100 grams of plant material adequate and desirable phosphorus concentration levels for alfalfa?

It has been demonstrated that calcium, magnesium, nitrogen, and phosphorus are frequently antagonistic to potassium uptake, and it is desirable that the interpretation of soil tests and even plant tissue tests should be given consideration to nutrients other than potassium when investigating this nutrient.

SWCRD, ARS, USDA, Logan, Utah.

Bernstein, L. SALT TOLERANCE OF GRASSES AND FORAGE LEGUMES. U.S. Dept. Agr., Agr. Inform. B. 194, 7 pp. 1958.

Salt tolerance is the degree to which a crop can produce a satisfactory yield on salty land.

Forage crops are important in farming salty lands because: (1) They may be low cost crops for marginal land; (2) they may improve soil structure on reclaimed land; and (3) they may produce good yields of forage or seed on salty land, provided salt-tolerant species are planted.

The primary effect of salt is to decrease the availability of water.

The salt tolerance of different grasses and forage legumes are:

Good Salt Tolerance

(12 to 6 millimhos)

Alkali sacaton (Sporobolus airoides)
Saltgrass (Distichlis stricta)
Nuttall alkali-grass (Puccinellia nuttalliana)
Bermuda grass (Cynodon dactylon)
Tall wheatgrass (Apropyron elongatum)
Rhodes grass (Chloris gayana)
Rescue grass (Bromus catharticus)
Canada wildrye (Elymus canadensis)
Western wheatgrass (Agropyron smithii)
Tall fescue (Festuca arundinacea)
Barley (hay) (Hordeum vulgare)
Birdsfoot trefoil (Lotus corniculatus)

Moderate Salt Tolerance

(6 to 3 millimhos)

White sweetclover (Melilotus alba)
Yellow sweetclover (Melilotus officinalis)
Perennial ryegrass (Lolium perenne)
Mountain brome (Bromus marginatus)
Harding grass (Phalaris tuberosa var. stenoptera)
Beardless wildrye (Elymus triticoides)
Strawberry clover (Trifolium fragiferum)
Dallis grass (Paspalum dilatatum)
Sudan grass (Sorghum sudanense)
Hubam clover (Melilotus alba var. annua)
Alfalfa (Medicago sativa)
Rye (hay) (Secale cereale)
Wheat (hay) (Triticum aestivum)
Oats (hay) (Avena sativa)
Orchard grass (Dactylis glomerata)
Blue grama (Bouteloua gracilis)
Meadow fescue (Festuca elatior)
Reed canary (Phalaris arundinacea)
Big trefoil (Lotus uliginosus)
Smooth brome (Bromus inermis)
Tall meadow oatgrass (Arrhenatherum elatius)
Milkvetch (Astragalus species)
Sourclover (Melilotus indica)

Poor Salt Tolerance

(3 to 2 millimhos)

White Dutch clover (Trifolium repens)
Meadow foxtail (Alopecurus pratensis)
Alsike clover (Trifolium hybridum)
Red clover (Trifolium pratense)
Ladino clover (Trifolium repens forma gigenteum)
Burnet (Sanguisorba minor)

ARS, USDA, Inform. Div., Washington 25, D. C.

Dewey, D. R. SALT TOLERANCE OF TWENTY-FIVE STRAINS OF AGROPYRON. Agron. J. 52: 631-635. 1960.

The salt tolerance of 25 strains representing 14 species of Agropyron was measured in artificially salinized field basins and in laboratory germination tests. Four salinity levels, 0, 6,000, 12,000, and 18,000 p.p.m. of a mixture of NaCl and $CaCl_2$ were applied in the irrigation water.

On the average, increased salinity decreased forage yield on a strongly linear scale. Differences among species were evident in salinized plots. Agropyron elongatum was distinctly superior in salt tolerance to all other species included in the experiment. The yield of this species was not decreased at any salt level. A. inerme and A. spicatum were the species most sensitive to salt, and most plants of these species were dead at the 18,000-p.p.m. level by the end of the first growing season.

Many strains within species differed from one another. Topar pubescent wheatgrass was inferior in field salt tolerance to the other two strains of the same species. Greenar intermediate wheatgrass was less salt tolerant than Ree or Amur. These and other differences among strains within species strongly indicate that selection for salt tolerance within a species might isolate strains with greater salt tolerance.

Germination percent decreased and germination time increased linerarly as salinity was increased. Species and strains differed in germination percent at each salt level. Relative performance of species and strains in germination tests and field tests were somewhat different. Correlation coefficients between germination and yield in field basins at 6,000, 12,000, and 18,000 p.p.m. were .57, .63, and .24, respectively. None of the correlations are large enough to be of predictive value.

Results indicate that selection first on the basis of germination tests an then in salinized field basins should materially increase the salt tolerance of a given strain.

CRD, ARS, USDA, Logan, Utah.

Turner, T. HAY PRODUCTION INCREASED 7-FOLD, CATTLE 10-FOLD. Soil Conserv. 26: 27-29. 1960.

Replacement of native meadow grasses with alfalfa and improved grasses and more efficient water use are enabling John Rutman to produce seven times as much hay on his Devil's Gate Ranch near Elko, Nevada.

When Rutman purchased the ranch in 1949, he cut 450 tons of meadow hay from 1,000 acres. Now he averages 3,000 tons from 800 acres. In 1949, the ranch was supporting 260 head of cattle, but now Rutman runs between 2,000 and 3,000 head.

The irrigation system on the Devil's Gate Ranch includes about 45 miles of canals, and numerous water control structures. Around 800 acres have been leveled for more efficient irrigation, from 50 to 100 acres being leveled each fall. Between 400 and 500 acres remain to be leveled. Border ridges are used to obtain better efficiency in water use.

"The soil and water conservation program is the greatest thing that has come to farmers and ranchers in this country," declares John Rutman. "The trouble is that too many are sticking to the methods used by their forefathers instead of adopting modern practices."

SCS, USDA, Wells, Nev.

Peterson, M. L., Osterli, V. P., and Berry, L. J. MANAGING IRRIGATED PASTURES. Calif. Agr. Expt. Sta. Ext. Serv. C. 476, 31 pp. 1959.

Irrigated pastures can help diversify and balance feed production on the farm--also conserve and improve the soil.

The goals of good pasture management are: (1) To produce efficiently as much meat or milk per acre as possible; (2) to obtain and continue the highest possible grazing capacity per acre; (3) to use the feed when its nutritive value is most advantageous; and (4) to maintain an adequate stand and balance of legumes and grasses throughout the pasture season.

These goals can be achieved, with a good yield of quality feed if the farmer will: (1) Grade and prepare the land to get efficient irrigation and good drainage of excess water; (2) use an adapted mixtures of legumes and grasses; (3) apply the right kind and amount of fertilizer; (4) prevent or control undesirable weedy plants; (5) manage grazing to utilize fully the feed produced; and (6) manage irrigation to provide continuous supply of water to the plants.

Irrigated pastures have become an important factor in land utilization in California, proving profitable where other cultivated crops have not been permanently successful. Many California farmers include irrigated pasture plantings in the rotation system.

This is a discussion of the installation and management of irrigation pastures.

Calif. Agr. Expt. Sta. Ext. Serv., U. Calif., Berkeley, Calif.

Lewis, R. D. MOUNTAIN MEADOW PROBLEMS - WITH SUGGESTIONS FOR IMPROVEMENT. Proc. Eleventh Annual Fert. Conf. of the Pacific Northwest, Salt Lake City, Utah. July 13-15, 1960. pp. 59-64. 1960.

During the past 75 years or more, stockmen in the eleven Western States have depended upon mountain meadowlands for 4 to 6 months winter feed to support their livestock enterprises. The amount of winter hay and of spring and fall pasture produced determines largely the number of cattle a ranch may carry. Through study and adaptation, the livestock producers have developed a system of management suited to range, pasture, and meadow-forage production.

The present day system of management is not stable; however, it must be changed as time and economic conditions dictate. Presently the forage yields from the meadows are extremely low, operation costs high, and the availability of public lands for grazing purposes is declining each year because of grazing restrictions. New adjustments in the management system are confronting the rancher today. Before new adjustments can be made in the management system to meet present day economic conditions, the forage yield and quality produced from the meadowlands must be increased.

The ranchers are presently faced with some difficult soil and water management problems in trying to rejuvenate the meadows and bring them back into profitable production. For one thing, the rancher knows that he is faced with these problems and that if he is to stay in the livestock business, he must work out an economic management practice for the solution of them.

Research shows the following four major steps involved in the improvement of forage production on each of the four mountain meadow groups: (1) Better water management essential; (2) establishment of higher-yielding forage varieties; (3) commercial fertilizer essential; and (4) time of harvest important.

The rancher is faced with many rather difficult soil and water management problems in trying to keep up forage yields and quality in the meadow areas and maintain a profitable livestock management program.

The rancher should obtain an aerial picture of his land, a report on the soil, a land-capability map, an inventory of forage producing crops, and water management practices and assistance in preparing an overall ranch management plan.

With the above information and proper planning, the rancher will be able to introduce a sound management program.

SWCRD, ARS, USDA, Laramie, Wyo.

Johnston, A., and Peake, R. W. EFFECT OF SELECTIVE GRAZING BY SHEEP ON THE CONTROL OF LEAFY SPURGE (EUPHORBIA ESULA L.). J. Range Mangt. 13: 192-195. 1960.

A study was undertaken to determine the effectiveness of selective grazing by sheep on the control of leafy spurge. A study site was selected that was badly infested with leafy spurge and that had previously been seeded with crested wheatgrass. Grazing started in 1952 and was continued until 1956. During this interval, vegetation changes were followed with the vertical point method.

The results show that selective grazing by sheep is an effective method for use in controlling leafy spurge and that at least four years of grazing are required before such control can be attained. During the study period the basal area of crested wheatgrass increased significantly ($P<0.01$) whereas that of leafy spurge showed a significant decrease ($P<0.01$). Observations made during the course of the experiment are discussed.

Canada Agr. Res. Sta., Lethbridge, Alberta, Canada.

Ehrenreich, J. H., and Buttery, R. F. INCREASING FORAGE ON OZARK WOODED RANGE. Central States Forest Expt. Sta. Tech. Paper 177, 10 pp. illus. 1960.

Most Ozark ranges are all or partly wooded. Nevertheless, nearly all such sites will grow dense stands of grass if the stand of trees is removed or kept open. One relatively treeless acre can produce as much forage as 40 to 60 acres of well-stocked forest.

The big problem is controlling the woody plants and weedy herbaceous vegetation on that one acre so as to increase forage production. To help solve this problem, a study was begun in 1956 to find out how burning, girdling, poisoning, seeding, and fertilizing affect forage production.

The study was made on the Sinkin Experimental Forest near Salem, Missouri. The area is typical of much of the fair to poor timbered range found on the ridgetops and flats throughout the central Ozarks. The most abundant grass on the area is poverty oat grass (Danthonia spicata (L.) Beauv.). It is accompanied by a very sparse stand of more palatable grasses such as little bluestem (Andropogon scoparius Michx.). Trees consist mostly of black oak (Quercus velutina Lam.), blackjack oak (Q. marilandica Muenchh.), scarlet oak (Q. coccinea Muenchh.), and post oak (Q. stellata Wangenh.) with various other hardwood species. Soils of the area are classified as Clarksville stony l.

By the second season after treatment herbage production had increased 40 to 60 times on plots where both high and low hardwood competition was reduced by either of two methods--poisoning or a combination of girdling overstory trees and spring burning. The check areas produced less than 30 lbs. of herbage per acre per year, whereas, the treated areas produced more than 1,800 lbs. of herbage per acre.

Early spring burning alone without other hardwood control increased herbage production two to three times the first growing season following burning, an increase of only 70 to 80 lbs. of herbage per acre.

Part of the area was seeded to tall fescue (Festuca arundinacea Schreb.) Although total herbage production was about the same on both seeded and unseeded areas, forage on the seeded area was much higher in quality. Fescue and other palatable grasses such as little bluestem, big bluestem (Andropogon gerardi Vitman.), and Indiangrass (Sorghastrum nutans (L.) Nash.) and grass-like plants such as sedge (Carex spp.) made up most of the total herbage yield on seeded plots. Fescue made up 80 to 90 percent of the grass production and 60 to 80 percent of the total herbage on seeded plots. On unseeded plots most of the increased herbage production was forbs [such as partridge-pea (Cassia chamaecrista L.), bush clover (Lespedeza spp.), tick clover (Desmodium spp.), cinquefoil (Potentilla spp.), fireweed (Erechtites hieracifolia (L.) Raf.), horseweed (Erigeron canadensis L.), aster, (Aster spp.), and goldenrod (Solidago spp.)] and undesirable grasses. [such as poverty oat grass.]

Total herbage production reached a peak the second growing season after treatment and decreased in subsequent years on both seeded and unseeded plots. This decrease in herbage production was practically all in weedy forbs with production of grasses remaining the same or dropping only slightly.

The single application of fertilizer (4 tons lime and 584 lbs. of 10-30-15 per acre) had only a temporary effect--a 25-percent increase in yield the second season. On seeded plots fertilization resulted in more fescue, whereas, on unseeded plots it resulted in more forbs. Fertilization also increased seedling establishment of fescue and helped maintain a denser stand. The native grasses such as little bluestem showed little benefit from the fertilizers.

Central States Forest Expt. Sta., FS, USDA, Columbus, Ohio.

Pond, F. W., and Cable, D. R. EFFECT OF HEAT TREATMENT ON SPROUT PRODUCTION OF SOME SHRUBS OF THE CHAPARRAL IN CENTRAL ARIZONA. J. Range Mangt. 13: 313-317. 1960.

Seven chaparral species were burned and reburned with a hand torch at intervals varying from 1 to 5 years. Number of stems of shrub oak was reduced only after five annual burns. Burning less frequently produced more live stems than were present prior to the first burn. Skunkbush sumac was also hard to kill by burning, although results were more erratic than with shrub live oak. Wright's silktassel and hollyleaf buckthorn are easier to kill than shrub live oak or skunkbush sumac but must be burned at least twice within 3 years to be eliminated. Old plants of desert ceanothus, pointleaf manzanita, and larchleaf goldenweed are killed by one burn.

Reduction of the less desirable species of chaparral by repeat burning appears impractical. However, repeated fires at short intervals may reduce or eliminate many species performed by deer and livestock.

Rocky Mountain Forest and Range Expt. Sta., FS, USDA, Tempe, Ariz.

Elwell, H. M. LAND IMPROVEMENT THROUGH BRUSH CONTROL. Soil Conserv. 26: 56-59. 1960.

Millions of acres of land produce little of value because scrubby, woody vegetation prevents the growth of desirable grasses, legumes, or trees. Scientists are rapidly developing methods for conversion of brush lands to greater production through new and more efficient control methods.

Investigators agree that site consideration is highly important in determining whether brushland can be profitably treated. The best methods for eliminating brush vary greatly because of the wide range of woody plants and grasses and the differences in climate and soil.

The use of 2,4,5-T, 2,4-D, monuron, and fenuron on the various species of brush and trees is described.

Management practices such as fire protection and deferred grazing have been valuable aids in establishing desirable vegetation on brush-infested areas that have been treated with chemicals. Areas that have been accidentally burned 1 and 2 years after being treated have had more root sprouts than unburned areas. Litter on unburned areas reduces wind and water erosion while the grasses are becoming established. The oaks and hickory plants dying from the effects of 2,4,5-T usually fall in small segments; thus there is very little possibility of injury to grazing livestock.

Deferred grazing on native rangelands from May 1 to October 15 for two seasons following application of 2,4,5-T has permitted the native grasses to develop an excellent sod, good forage production, and fair seed yields.

CRD, ARS, USDA, Stillwater, Okla.

Martin, W. E., and Berry, L. J. NITROGEN FOR THOSE WINTER RANGES. Crops and Soils 13(3): 14-15. 1960.

A 5-year study on the use of nitrogen fertilizers on California annual rangeland has recently been concluded. Production of rangeland has been measured directly through weight gains of grazing cattle on fertilized and unfertilized fields, rather than indirectly through clipping of vegetation.

On-the-range studies of nitrogen fertilization of grass have been conducted since the fall of 1953. Located on private cattle ranches, the basic plan was to use weight gains of cattle as a measure of the value of fertilizer. An untreated field of 100 to 200 acres was compared with adjoining areas treated with nitrogen fertilizer--usually 60 to 80 lbs. of nitrogen per acre.

Sulfur or phosphorus was applied with nitrogen where either nutrient was known, by soil test, to be deficient. In such cases, ammonium sulfate, or one of the ammonium phosphates such as 16-20-0, was used as a nitrogen source.

Fertilizer was applied with a ground rig if feasible, or by airplane where the land was too rough for ground equipment. Fertilized and unfertilized fields were grazed during the same period. Grazing usually started 4 to 6 weeks after the first effective rains.

The fields were stocked with feeder animals weighing 400 to 600 lbs., at rates considered as normal for the feed available.

Carrying capacity was increased two and a half times by fertilization. Without fertilization it took an average of 3 acres to carry each animal for 114 days--or 38 head-days per acre. With nitrogen it took only 1 1/3 acres per animal for the same period--or 88 head-days of grazing per acre.

The average beef production per acre was increased from 60 to 164 lbs. This gain of 104 lbs. of beef was obtained at an average fertilizer cost of $13.61 per acre or 13.2¢ per lb. of extra beef. With beef selling for 20¢ per lb. or more this would give a profit of at least $7 an acre from using fertilizer.

Range fertilization with nitrogen helps provide extra feed in periods when grasses normally don't grow, thus lessening the need for supplemental feeding of cattle. It also provides a means of controlled grazing without fencing since animals tend to remain on fertilized areas during the early part of grazing season.

Best results have been noted on well-drained ranges where the seasonal rainfall is 15 to 25 inches. This amount of moisture, if well distributed, is enough for continued growth of annual grasses; but not so much as to cause nitrogen loss by leaching.

Also, winter temperatures must be relatively mild so as to permit grasses to grow and use the fertilizer nutrients. Grasses fertilized with nitrogen are better able to withstand occasional frost than are unfertilized plants.

As prices for land, rental values, and taxes increase in California, it is clear that rangeland will have to produce more feed per acre to show a profit.

Fertilizer is now being used to do this on ranges of high potential grazing capacity where there is the greatest possibility of increasing beef production. An average 1½ lbs. of beef for each lb. of fertilizer nitrogen is good business.

Calif. Agr. Ext. Serv., Davis, Calif.

Cox, M. P., and Cole, R. S. THE SOUTH DAKOTA METHOD OF SPECIFYING MIXTURES FOR RANGE SEEDING. J. Range Mangt. 13: 294-296. 1960.

Ranchers and government agencies have long been aware of a need for a better method of specifying and calculating mixtures for range seedings. Seeding-rate charts stated in pounds per acre are inadequate because they do not specify the full range of acceptable mixtures for specific environments while also considering purity and germination.

A range seed mixture requiring specific amounts of pure live seed of certain native species may be impossible to formulate if local seed of one or more species in the mixture is not available that year. Also, equipment capable of properly planting a fuzzy or chaffy seed, specified in a mixture may not be available locally. Any such obstacle can cause unfortunate delays in range seedings.

To overcome delays, plant technologists have developed a type of specification that reflects the rull range of acceptable range seeding mixtures for specific kinds of land. Needed flexibility in formulation of mixtures for individual cases is provided by seeding specifications that show the full range of tolerable variation in choice of species; and among these the tolerable range in amounts of each expressed as ranges in percentages of the mixture. Both different species and different percentage ranges can thus be prescribed for different kinds of land considering climate, soil, and the dominant species of the original or climax vegetation.

In South Dakota two climatic belts were differentiated. One with less than 20 inches of annual precipitation, and one with 20 or more inches. A table of seeding rates was prepared for each, showing different mixtures for seven range soil-groups recognized in each belt. Data for the area with less than 20 inches of precipitation are presented in this article.

The method provides for: (1) The correct quantity of seed regardless of mixture selected and quality of seed used; (2) inclusion of climax dominants adapted to the range site in each range seeding; (3) flexibility in selection of species for mixtures to allow for variable availability of seeds and suitability of available planting equipment; and (4) equitable federal cost-sharing based on pure live seeds, in mixtures adequate to restore excellent range condition for the type of site.

SCS, USDA, Phoenix, Ariz.

Knipe, D., and Herbel, C. H. THE EFFECTS OF LIMITED MOISTURE ON GERMINATION AND INITIAL GROWTH OF SIX GRASS SPECIES. J. Range Mangt. 13: 297-301. 1960.

Two hundred caryopses each of black grama, bush muhly, tobos, mesa dropseed, lehmann lovegrass, and boer lovegrass were germinated in petri dishes on blotter paper moistened with water-mannitol solutions of 0.3, 3.0, 7.0, 11.0, 15.0, and 20.0 atm. osmotic concentration (degrees of moisture stress). The object of the study was to determine differences, within and among species, in time required to germinate, total germination, and initial growth of seedlings under various conditions of moisture stress.

With the exception of lehmann lovegrass, time required to germinate was not greatly increased by increasing osmotic concentration from 0.3 to 7.0 atm. However, total germination of lehmann lovegrass, boer lovegrass, and mesa dropseed was significantly reduced by increasing osmotic concentration from 0.3 to 7.0 atm., and reduction in total germination of all species was very nearly significant under these conditions.

Generally, the growth of seedlings was significantly decreased by increasing osmotic concentration from 0.3 to 7.0 atm.

Of the species tested, black grama and bush muhly seem best adapted to survival under conditions of limited moisture. Seedlings of these species were the only ones which attained measurable growth when germinated and grown at 11.0 atm. osmotic concentration. None of the species developed measurable seedlings at 15.0 and 20.0 atm. osmotic concentration, but the caryopses of black grama and bush muhly germinated surprisingly well at these levels of moisture stress.

Jr. Author, CRD, ARS, USDA, Las Cruces, N. Mex.

Houston, W. R. EFFECTS OF WATER SPREADING ON RANGE VEGETATION IN EASTERN MONTANA. J. Range Mangt. 13: 289-293. 1960.

A study of vegetational changes on a range water-spreading system near Miles City, Montana, was made between 1951 and 1959. On a western wheatgrass dominated area of clayey soils two durations of water spreading were studied. Only one duration was studied on a blue grama grass dominated area of sandy loam soil.

Vegetation composition and cover were sampled by an adaptation of the loop-plot method. Heights of western wheatgrass and herbage production were determined.

From 1955 to 1959 herbage production was increased on the western wheatgrass area an average of 62 percent by flooding and 189 percent by temporarily ponding water. On the blue grama area average production was increased 353 percent by flooding. Production on all sites varied greatly between years.

Average heights of western wheatgrass plants were considerably increased by flooding on the blue grama area. Water spreading had little consistent effect on heights on the western wheatgrass area.

Litter cover on the blue grama area was slightly increased by flooding. There was no noticeable effect of water spreading on litter cover at the western wheatgrass area.

At the blue grama area, flooding gradusually reduced live-plant cover, but at the western wheatgrass area, water spreading had little effect on plant cover.

At the blue grama area, flooding almost reversed the proportions of blue grama grass and western wheatgrass, while on the control, the far greater composition of blue grama grass remained unchanged. At the western wheatgrass area, flooding caused no change in species proportions. However, on the control site the vegetation changed from predominantly western wheatgrass to an approximately equal mixture of western wheatgrass and blue grama grass.

Annual gross return per acre was seven to ten times the annual costs of the system per acre.

CRD, ARS, USDA, Miles City, Mont.

Rauzi, F. WATER-INTAKE STUDIES ON RANGE SOILS AT THREE LOCATIONS IN THE NORTHERN PLAINS. J. Range Mangt. 13: 179-184. 1960.

Water-intake studies were conducted with a mobile infiltrometer on rangelands at three locations in the northern plains. Two of the three areas (Williston, North Dakota, and McCone County, Montana) are in the 10- to 14-inch rainfall belt. The other area (Glacier County, Montana) is in the 15-to 19-inch-rainfall belt. Fenceline comparisons were made between pastures rated in either a high or low range condition. Soil texture for the sites was either silt loam or loam.

Ranges rated in high condition absorbed almost three times as much water in the form of simulated rain as the low-condition ranges during the fourth 15-minute period of the hour test. Ranged rated in high condition had more standing vegetation and mulch material present at the time of test than did those rated in low condition.

Regression analysis was used to compare variations in water intake with variations in forage and mulch yield. An over-all regression of the three areas indicated that the relationship between water-intake rates and amount of forage yield and mulch was highly significant, but only 41 percent of the variation in water intake was accounted for. Individual regressions for each area were then computed and it was found that from 45 to 84 percent of the variation in water intake was accounted for by mulch and forage yield in the individual areas.

Partial correlation coefficients indicated that on two of the three areas the amount of standing vegetation contributed more to water intake than mulch material. Apparently on these areas the amount of standing vegetation masked the effect of the mulch.

Although significant relationships between water-intake rates and amount of forage yield and mulch were established for all areas, the individual regressions for the different areas show a closer degree of association among the variables and, therefore, greater accuracy can be obtained from their use.

SWCRD, ARS, USDA, Laramie, Wyo.

Leithead, H. L. GRASS MANAGEMENT PAYS BIG DIVIDENDS. J. Range Mangt. 13: 206-210. 1960.

The grass management program that increased net returns from 4 to 83 cents per acre in eleven years on Howard Sachs' ranch was based on proper use of the key range grass, bluebunch wheatgrass, and a rotation-deferred system of grazing.

Grazing the same pasture early every spring did not cause range deterioration. One reason why the range held up over the years was that all livestock were moved off before the grasses were grazed too close, and while there was sufficient moisture in the soil profile for plants to start growth again and complete their normal growth cycle four years out of five.

The rotation-deferred system of grazing that Sachs follows was so designed that no pasture on the ranch, except the one used for early spring grazing, is grazed at the same time year after year. This makes it possible to defer the grazing of all the range one and sometimes two successive years during the period of rapid plant growth when food reserves are lowest in the root systems.

Under the system of grass management applied on this ranch, all the range improved in condition. On the better sites, the range improved as much as two condition classes.

Sachs kept livestock numbers in balance with the feed supply by adjusting the size of the breeding herd. Calves were held over and marketed as yearlings. The current year's feed supply largely governed the date yearlings went to market.

Livestock were moved from pasture to pasture every two to three weeks. They were moved when it was determined the forage in the pasture had been properly used and not on a predetermined calendar date.

SCS, USDA, Denver, Colo.

GRASS MANAGEMENT

TABLE .--Annual Production Cost and Net Returns to Range Improvement and Management Per Acre of Rangeland

	1947	1948	1949	1950	1951	1952	1953	1954	1955	1956	1957
Total pounds of beef produced from rangeland	24,591	27,021	30,810	38,440	41,250	44,255	58,680	64,640	69,041	59,054	62,844
Pounds of beef produced per acre of rangeland	2.9	3.2	3.6	4.5	4.9	5.2	7.0	7.6	8.2	7.0	7.4
Gross income per acre from beef @ 18.5 per pound	$.54	$.59	$.68	$.85	$.91	$.96	$1.28	$1.40	$1.51	$1.28	$1.38
Total land and livestock costs per acre of rangeland	.50	.51	.52	.53	.55	.55	.58	.59	.61	.61	.55
Net return to range improvement and management	$.04	$.08	$.16	$.32	$.36	$.41	$.70	$.81	$.90	$.67	$.83

Goebel, C. J., and Cook, C. W. EFFECT OF RANGE CONDITION ON PLANT VIGOR, PRODUCTION, AND NUTRITIVE VALUE OF FORAGE. J. Range Mangt. 13: 307-313. 1960.

Studies were conducted on desert ranges in southwestern Utah during 1955 and 1957 to determine effects of range condition on plant density, floristic composition, herbage production, vigor of plants, chemical content of vegetation, and certain physical characteristics of the soil.

Range condition had a pronounced effect on the expression of vegetation on the range. Good-condition ranges generally had a slightly higher density, a more desirable floral composition, and higher production than poor-condition ranges.

Good forage species on poor ranges were higher than poor forages in percent total protein, ash, cellulose, other carbohydrates, and phosphorus, but good forage species on good ranges were higher than poor forage species only in percent ash and cellulose.

Generally, a decrease in range condition is accompanied by a decline in length of leaves and stems, and in number of length of flowering stalks on good forage species. In addition, grass species in good vigor produce more caryopses per flowering stalk than those in poor vigor. Viability of caryopses produced by plants in good and poor vigor showed no significant differences.

Rates of infiltration were faster and water penetration was wider and deeper in soils of good-condition ranges compared to poor-condition ranges. Bulk-density was significantly higher on poor-condition ranges. There were no significant differences in amount of organic matter between good and poor ranges.

Coarse-textured soils had significantly higher infiltration rates and bulk-density values than fine-textured soils.

Iowa State Col., Ames, Iowa.

Klipple, G. E., and Costello, D. F. VEGETATION AND CATTLE RESPONSES TO DIFFERENT INTENSITIES OF GRAZING ON SHORT-GRASS RANGES ON THE CENTRAL GREAT PLAINS. U.S. Dept. Agr. Tech. B. 1216, 82 pp. 1960.

The effects of grazing intensity on short-grass vegetation was studied at the Central Plains Experimental Range in northeastern Colorado. Three intensities of grazing were applied from May 10 to November 10 each year from 1940 to 1953.

The Central Plains Experimental Range is in the 10- to 15-inch average annual rainfall belt. The 15-year (1939-53) average annual precipitation was 11.96 inches.

Important results from the study include the following:

1. Removal of nearly 60 percent by weight of the current growth of short-grass vegetation by early November was too heavy grazing for maintaining satisfactory range conditions and for making best gains by the cattle.
2. Where 40 percent by weight of the current growth was used, ample forage was available to maintain the cattle in thirfty condition all season. Production by the dominant grasses was maintained. Highly palatable plants usually survived, and the general condition of the range was maintained or improved.
3. Where less than 30 percent by weight of the current growth was grazed, cattle had access to surplus forage at all times. Highly palatable species like needle-and-thread and winterfat increased in frequency of occurrence. Dominant grasses increased in vigor and yield.
4. Light grazing was characterized by distinct patches of grazed vegetation surrounded by areas of

almost ungrazed vegetation. Plants of low palatability, such as three-awns, broom snakeweed, rubber rabbitbrush, and slenderbrush eriogonum, seldom showed grazing use.

5. Moderate grazing was characterized by patches of almost unused vegetation surrounded by areas of grazed vegetation. A larger percentage of the total area was grazed. Except for the highly palatable plants, stubble heights of grazed plants were much the same as under light use. Nearly all the highly palatable plants were grazed, and the remaining stubble on grazed plants was shorter than under light use. Some grazing was evident on plants of low palatability.
6. Heavy grazing was characterized by a distinct uniform appearance of the range. Areas accessible to cattle were grazed at least once, and many areas were worked several times. Needle-and-thread and winterfat showed repeated grazing. It was often difficult to find even the stubble of needle-and-thread. Species of low palatability usually were grazed.
7. Cattle on the heavily grazed areas produced significantly smaller weight gains per head during the May-November period than cattle on moderately and lightly grazed areas. The differences between the weight gains per head of the moderately and lightly grazed cattle were not significant.
8. Cattle that grazed the heavy-use pastures continued to gain weight through September, but usually lost weight during October. The cattle on moderately grazed pastures usually maintained their weight during October; those on lightly grazed pastures usually made small gains.
9. Larger weight gains per acre were produced under heavy grazing than under either moderate or light grazing.
10. Death losses among cattle on heavily grazed pastures were significantly larger than the losses among cattle on moderately or lightly grazed pastures. Many of the cattle on heavily grazed pastures were unable to maintain good thrift.
11. Responses of the cattle to the grazing treatments was summed up in the gross money value return to the ranch income for the forage harvested from a section of rangeland. Under actual grazing use the 10-year (1940-49) average annual return per section to ranch income from moderate grazing exceeded that for heavy grazing use by $255 and that for light use by $333.
12. Cattle costs per section of rangeland under heavy grazing were approximately 71 percent higher than the cattle costs per section under moderate grazing.

FS, USDA, Inform. Div., Washington 25, D. C.

Weaver, J. E. EXTENT OF COMMUNITIES AND ABUNDANCE OF THE MOST COMMON GRASSES IN PRAIRIE. Bot. Gazette 122: (1): 25-33. 1960.

Sixty-three typical prairies scattered throughout an area of 60,000 square miles of the central Missouri Valley region were carefully analyzed. The *Andropogon scoparius* and *A. gerardi* communities, respectively, composed 58 and 39% of the grassland. Other communities--*Stipa spartea*, *Sporobolus heterolepis*, and *Spartina pectinata*--together occupied the remaining 3%. The *A. scoparius* community occupied 6-11% more area in western Iowa than *A. gerardi*, 23% more in southeastern South Dakota, 12% more in eastern Nebraska, 14% more in northeastern Kansas, and 58% more in north-central Kansas and adjacent Nebraska.

In the sections with 32-34 inches of rainfall, average percentages for the two types were 54 and 44; in those with 24-26 inches precipitation, percentages were 69 and 29. In the 63 prairies, the *Andropogon scoparius* community was the most extensive in 67% and the *A. geradi* community in 25%. They were approximately equal in area in the remaining 8%.

As individual species, *Stipa spartea* was present in nearly all of 70 praries but was most abundant in northern areas. *Koeleria cristata* occurred in all, mostly in amounts of 1-3%. *Sporobolus heterolepis* was absent from northeastern Nebraska and north-central Kansas.

In many Iowa prairies and in northeastern Kansas it was common to abundant, but often it occurred only in amounts of 1-5%.

U. Nebr., Lincoln, Nebr.

Ellison, L. ROLE OF PLANT SUCCESSION IN RANGE IMPROVEMENT. In Grasslands, Amer. Assoc. for the Advancement of Sci. pp. 307-321. 1959.

With natural, secondary plant succession, the central question has been--How it is possible to maintain a high level of range productivity under grazing?

Range plant composition and productivity are determined in part by grazing pressure. Other factors, such as recurrent drought and interactions between plant species, may be just as important, or more important. Some species that are severely handicapped and reduced by heavy grazing are otherwise well adapted to the environment. In the course of succession under grazing their place is commonly taken by opportunists that are unpalatable or that by other means escape the handicap of heavy grazing. When grazing pressure is lightened, at least some of the more palatable members of the original vegetation are able to reassert themselves, and other factors, such as the competition of these species, reduce the opportunists.

It is probably too much to say that pristine vegetation can be maintained under livestock grazing. Experience is generally showing, nevertheless, that a level of productivity much closer to the pristine can be maintained than has generally been supposed possible.

Intermountain Forest and Range Expt. Sta., FS, USDA, Ogden, Utah.

Plant Materials

Welton, K. INTRODUCTION OF NEW PLANT MATERIALS IN THE CORN BELT STATES, PART TWO. J. Soil and Water Conserv. 15: 205-209. 1960.

The first part of this article in the July issue of the JOURNAL traced the early work of the Soil Conservation Service nurseries and their successors, the plant materials centers.

This second part of the article chronicles specific plant materials being studied and their adaptations in the field.

SCS, USDA, East Lansing, Mich.

Crops Research Division. PERSIAN CLOVER--A LEGUME FOR THE SOUTH. U. S. Dept. Agr. L. 484, folded. 1960.

Persian clover is a winter annual legume native to southern Asia Minor and the Mediterranean countries. It is adapted to the southern United States, where it is used primarily for pasture and hay.

It produces forage in late and early spring, when southern grasses are dormant. It is nutritious and is liked by all kinds of livestock and poultry.

When it is grown with grasses, Persian clover improves the quality and quantity of the grasses by furnishing nitrogen. Once established in properly managed plantings, it reseeds itself year after year.

In some areas, Persian clover is used for green manure or for silage as well as for pasture and hay.

This is a culture and care leaflet on Persian clover.

Persian clover green-manure crops yield as much as 30,000 lbs. of green material per acre. The green-manure crop can be grazed lightly early in the season, or a seed crop can be harvested before turning under the green manure.

If Persian clover is allowed to approach maturity before it is turned under, it yields a maximum of green material and sets enough seed to replenish itself for 2 years.

ARS, USDA, Inform. Div., Washington 25, D. C.

McMillan, I. I. PROPAGATION OF QUAIL BRUSH (SALTBUSH). Calif. Fish and Game 46: 507-509. 1960.

In semi-arid central and southern California, especially where the average annual rainfall is below 10 inches, the natural, original plant cover on some large areas, was presumably a shrub-grassland with quail brush, *Atriplex*, the dominant shrub. In places this shrub-cover remains to indicate its former status, but most of the grasses and forbs that were its aboriginal associates are gone, replaced by alien plants of old-world origin.

In a program to rehabilitate the quail populations of this same region, protective ground cover has been found to be a principal need. Dense stands of this plant grown from seed have been established successfully and have proved to be the ideal protective cover for California quail. One hedge of this shrub, approximately 200 feet long and eight feet wide has been the exclusive daytime, winter cover of a covey that in recent seasons has numbered from 400 to 600 birds. This hedge was planted in 1952 and was well matured after four years growth.

Transplanting the seedling shrubs has been done and may be advisable where only a few plants are wanted, however, propagation from the seed is much more practical and successful for cover patches or general range rehabilitation. The seeds are produced in dense clusters on the outer tips of the branches and mature in late fall. December is a good time to gather them. They can be collected easily by stripping the outer branches so that the seeds fall on a canvas or cloth stretched on the ground.

At least four species of *Atriplex*, native to California and this region can be used. The species *A. lentiformis* and *A. breweri* are the largest and quickest growing, but require more moisture than *A. polycarpa* or *A. canescens*. *A. polycarpa* has the widest range in central California and is evidently the best adapted to propagation as quail cover.

Quail brush prefers a firm, smooth, well packed seedbed, free of other plants. The seed can be broadcast on the surface. Following this, a light drag that will merely incorporate the seed with the surface soil, and at the same time pack and smooth the seedbed has been most effective.

The amount of seed to be used depends on the type of stand desired and the rainfall of the area as well as the species selected. A rate of 100 lbs. per acre of *Atriplex polycarpa* seed is adequate for a thick stand.

After germination, quail brush is thrifty and hardy, and needs no further cultivation or care except that it must be protected from damage by sheep or cattle. After it is established, however, the right amount of browsing actually stimulates growth and does not damage the plant.

Shandon, California.

Coffman, F. A., and Stevens, H. OAT VARIETIES IN THE WESTERN STATES. U. S. Dept. Agr. Agr. Hbk. 180, 19 pp. 1960.

Oats grown in the Western States differ greatly as to type because of the wide range of climatic and crop conditions. Some varieties are adapted for growing over wide areas under different farming systems, and others are grown in limited areas and are comparatively narrow in their adaptation.

Oat varieties grown in the western half of the United States are classed in general as spring or winter, midseason or early, "white" or "red." Spring oats are midseason or early-maturing varieties grown almost exclusively from spring seeding. Winter oats are grown primarily from fall seeding, although under some conditions they may be sown in late winter or very early spring.

The descriptions "white" and "red" have been used loosely for decades to differentiate oats classed botanically as belonging to *Avena sativa* and those classed as belonging to *Avena byzantina*. Among the so-called white oat group are some varieties that are actually white and some that are yellow, gray, or even black in kernel color. Among the red oat group are some varieties that are red, gray, black, and reddish-yellow or reddish-white. As a result, differentiation of white and red varieties has been made more and more on botanical characters other than color; and on the basis of these other characters varieties are assigned to the type they most closely resemble.

Lists of recommended varieties of oats are given for each area of the Western United States along with a description of the leading varieties grown.

ARS, USDA, Inform. Div., Washington 25, D. C.

Byrd, M., and Young, W. C. BROWNTOPMILLET FOR WILDLIFE. Soil Conserv. 26: 34-35. 1960.

More than 200,000 lbs. of browntopmillet seed was harvested in Mississippi, Louisiana, and Arkansas during the 1959 season. This crop is new to these States, but production has boomed as a result of its demonstrated value as a choice food plant for wild ducks. The millet has also been useful as food for bobwhite quail and mourning doves. A few farmers and ranchers have used it for hay.

In the field plantings, widely dispersed over the area, browntopmillet has proven to be suited to the climate and adapted to most soils. Browntopmillet must be planted where it can be flooded during the winter season for duck use. For bobwhites and doves, any open area is suitable. In the area studied, it has proven adaptable to soil conditions in the Grand Prairie of Arkansas, on the Coastal Prairie soils of Louisiana, on the Delta soils of Mississippi, and on most of the Coastal Plains soils in the three States. Inadequate drainage during the growing season has been the only limitation to successful management.

The crops does not demand heavy fertilization, though some fertilizer was used on most plantings. The analyses and rates of fertilizer were those commonly recommended for grain crops in that area. It was observed that on alluvial or more fertile soils, no additional nitrates were needed to produce adequate seed crops. But on the poorer soils, especially of the Coastal Plains, rates up to 100 lbs. of ammonium nitrate per acre were beneficial. Higher rates of nitrogen produced larger and more vigorous vegetative crops, but adversely affected seed yields

June and July plantings were best for this area. An average of 8 fields in 1958 yielded 1,700 lbs. of seed per acre in the Coastal Prairie section of Louisiana from plantings in June and July. A July planting in the Bolivar County Soil Conservation District, Mississippi, yielded 2,700 lbs. of seed per acre. August plantings, on the other hand, yielded only 250 lbs. of seed per acre in the vicinity of Little Rock, Ark.

One field of 40 acres in the Lake Charles, La., area was sown by airplane in mid-June of 1958. This same field, after being combine-harvested, was flooded for ducks at the beginning of the season and supported about 7,000 ducks for the first three weeks. It then continued to support about 100 ducks for the remainder of the season. This indicates that seed harvesting can be combined with actual use for wildlife purposes.

All field plantings of browntopmillet which were adequately managed and later flooded for ducks attracted and held them. In a few instances this did not occur until the shooting season was over.

SCS, Little Rock, Ark.

Linduska, J. MULTIFLORA ROSE--THE MULTIPURPOSE SHRUB. Ill. Wildlife 16(1): 6-7. 1960.

Multiflora is at its best in the humid, eastern half of the country from the Mississippi to the coast. It prefers moderately heavy soils but can be brought along on lighter ground if mulched and fertilized liberally. It won't grow in dense shade or on poorly drained land.

To fence pastures, a double row is best. Set the young plants a foot or 18 inches apart. Locate a second row two to three feet from the first and interplant the gaps by staggering the plants.

Multiflora is a full-time all-purpose friend of the farmer. No other plant can boast the ability of containing cattle while excluding trespassers the year around, of functioning as a snow fence in winter and a nursery for songbirds in the spring, and of being a predator-proof escape hatch for rabbits and game birds. With all this, it adds an element of beauty to the farm scene that's in sharp contrast with bleak barbed wire.

Wildlife Managt., Remington Arms Co., Inc.

Oertel, E. HONEY BEES IN PRODUCTION OF WHITE CLOVER SEED IN THE SOUTHERN STATES. U. S. Dept. Agr., Agr. Res. Serv. ARS-33-60, 8 pp. 1960.

Pollinating insects are necessary for the production of white clover seed.

Certain wild bees, principally bumble bees and solitary bees, pollinate white clover (Trifolium repens L.), but their number is small. Honey bees (Apis mellifera L.) are by far the most numerous pollinating agents, and their number in an area can be increased by moving colonies to the field.

Large fields of clover present a big job of pollination. An acre of white clover may contain from 1 to 3 million open florets per day during the flowering season, which, in the Southern States, is mainly in March, April, and May. Fortunately, white clover is attractive to honey bees as a source of both pollen and nectar.

Some honey bees gather only pollen from white clover, some only nectar, and many gather both. The nectar gatherers perform an important pollinating service, since they crawl over the pollen-bearing stigmas in order to reach the nectar at the base of the floret. Pollen grains cling to the finely branched hairs that cover the bee's body and are carried from one floret to another, thus effecting cross-pollination.

This article reports on the role of the honey bee for the production of white sweet clover seed, and explains how to increase the production of white clover seed by the use of bees.

ARS, USDA, Inform. Div., Washington 25, D. C.

Woodlands

Olson, D. F., Jr., and Della-Bianca, L. SITE INDEX COMPARISONS FOR SEVERAL TREE SPECIES IN THE VIRGINIA-CAROLINA PIEDMONT. Southeastern Forest Expt. Sta. Paper 104, 9 pp. 1959.

Total height and total age were obtained for dominant and codominant trees of as many species as possible in 155 upland, northern Piedmont forest stands. From two to seven species were found associated on each of the plots. Site index equations were developed for oak, yellow-poplar, and shortleaf pine growing in these mixed forests of the Virginia-Carolina Piedmont. The site index of other species was determined with the use of published curves.

The site indices of all species were compared, and yellow-poplar was the only widely occurring species with a sufficient range of site index to serve as an index species. Using yellow-poplar as the independent variable, equations were computed for estimating the site index of scarlet and northern red oak, black oak, white and southern red oak, and shortleaf pine. These were presented in chart form and make it possible to estimate the site index of any of these seven major species if the site index of yellow-poplar can be determined by conventional means.

Though direct comparisons with yellow-poplar could not be made for sweetgum and Virginia pine, the role of these two species in upland, northern Piedmont forests is discussed.

The most significant results of these site index comparisons are: (1) Yellow-poplar exceeds all other Piedmont species in site index on sites which are 81 feet or more for poplar; (2) as the site index for yellow-poplar falls below 81 feet, the oaks, shortleaf, and Virginia pine begin to exceed yellow-poplar in site productivity, and yellow-poplar becomes the poorest of the seven species at site index 57 and under; and (3) throughout the range of yellow-poplar site index from 58 to 130 feet, shortleaf pine has a lower indicated site index than any of the commonly associated Piedmont species.

Southeastern Forest Expt. Sta., FS, USDA, Asheville, N. C.

Watt, R. F. SECOND-GROWTH WESTERN WHITE PINE STANDS: SITE INDEX AND SPECIES CHANGES; NORMALITY PERCENTAGE TRENDS; MORTALITY. U. S. Dept. Agr. Tech. B. 1226, 60 pp. 1960.

Several analyses of data gathered on 94 permanent plots in second-growth western white pine stands from 20 to 100 years old were made. The plots, which represent a variety of age, site, density, and composition conditions, were remeasured periodically to give information for 340 5-year growth periods.

Diameter and height measurements, and on 38 of the plots mortality information, were the most important data taken at each remeasurement.

Four principal analyses were made: (1) Repeated site index determinations were analyzed to see if site index changed with time and, if so, what factors influenced the rate of change; (2) an analysis was made to determine the changes in species composition with time to aid in understanding the development of second-growth stands; (3) the trends in density, in terms of normal stocking and methods of predicting such trends, were investigated; and (4) the mortality records were studied to determine the causes of mortality, the amount that occurs during growth from 30 to 100 years of age, and the stand factors that bear on the volume of mortality.

The study of site index changes determined that a statistically valid trend in site index occurred, but that the changes in site index were too small to have practical significance.

Analysis of species composition changes showed that the composition of western white pine stands is established by the time the stands reach 30 years of age, and that changes in composition up to the age of 100 years are small. The trends in species composition are in accord with the known silvical characteristics of the species. The very intolerant seral species, western larch and lodgepole pine, registered gains in the young-age class and on the poor site. White pine, in contrast, showed losses in these same classes. However, the advantage of early rapid growth of larch and lodgepole pine was lost with increasing age, and these two species decreased in importance in older stands. In contrast, white pine increased its proportion of the stand. Douglas-fir showed about the same pattern of gains and losses as the larch and lodgepole pine. The tolerant species that form the climax in the white pine type--grand fir, western hemlock, and western red cedar--gained in almost all age classes. These changes in composition are for stands free from white pine blister rust and pole blight, two diseases that are specific to white pine. Any changes in composition desired by the forester in a young stand of white pine must be brought about by some methods of cultural treatment.

The study of changes in normality percentage, the density in terms of normal yield-table values of stocking, showed that stands do change in density with age. The factors that influence changes in normality percentage over a 5-year period are initial normality percentage, age, and composition index. By using these three factors, multiple regression equations were developed for predicting normality percentage changes. Because of the overwhelming importance of initial normality percentage, equations were also derived for the prediction of normality percentage changes based solely on the initial normality percentage. The multiple regression equations can be solved quickly by alinement charts that are presented.

These regression equations can be used in conjunction with the normal yield tables for the western white pine type to give improved estimates of growth. If predictions are made for 20 to 30 years for large areas with a variety of stand conditions, the predicted and actual growth should be in good agreement. It should be emphasized that variability of mortality is the factor that makes any method of growth prediction so liable to error.

The fourth major analysis, that of mortality, showed that about half of the total mortality was attributed to wind and snow damage. Other important causes of mortality were insects, diseases, and suppression. Mortality caused the loss of 30 percent of the basal area, 22 percent of the cubic-foot volume, and 10 percent of the board-foot volume produced as the stands grew from age 30 to 100 years. Much of this loss is in timber that may become merchantable if the trend toward use of smaller trees continues in this region. Eighty percent of the cubic-foot volume lost was in trees 4.6 inches and larger, which may in the future be salable for pulp and fiber products.

The volume of mortality in a stand during a 5-year period was found to be correlated with the age and volume of the stand, two closely correlated stand variables. Of these two variables, stand volume was the more important.

Regression equations were developed to see whether mortality could be predicted. However, the great variability of mortality from period to period did not permit any mortality prediction because wind and snow, the most important agents of mortality, are as variable in their actions and results as the weather conditions that determine them. Insect and disease losses are also highly variable and irregular.

FS, USDA, Inform. Div., Washington 25, D.C.

Ryker, R. A. CONIFERS VS. HARDWOODS ON OLD-FIELD SITES. Central States Forest Expt. Sta. Note 122, 2 pp. 1958.

Three pines (loblolly, shortleaf, and white), redcedar, and three hardwood speicies (yellow-poplar, white ash, and black walnut) planted on two upland old-field sites in southern Illinois show marked differences in height growth after 11 years. Survival is good for the conifers, but poor for all hardwood species.

The sites are similar in terms of soil and past use, but different in topography and amount of erosion. Both have yellow silt-loam soil of loessal origin and had not been cultivated for 10 to 12 years before planting.

The better site is a nearly level, broad ridgetop, only slightly eroded and covered with broomsedge. Topsoil is approximately 7 inches deep and the subsoil about 16 inches. Below this is undifferentiated loess. Organic material has been deposited to a depth of about 1 2 inch.

The poorer site is a severely eroded, northeast-facing, upland slope with a light cover of annual weeds and grasses. All of the topsoil and part of the subsoil had been eroded from the middle portion of the plots while the upper and lower slope portions of the plots have about 5 inches of topsoil and 14 inches of subsoil.

Two hundred trees of each species were planted on each area at a 6 x 6 foot spacing. Black walnut was seeded with two nuts per spot and white pine was 2-2 planting stock. Planting stock for all other species was 1-0 seedlings.

The average 11-year survival for the conifers is 84 percent on the better site and 89 percent on the poorer site. For the hardwoods, average survival is 72 percent on the better site and only 47 percent on the poorer site. Yellow-poplar on the better site is the only hardwood that shows any promise; however, many of these trees have poor form.

After 11 years loblolly pine is tallest, shortleaf pine is next, and white pine third. The growth rate of eastern white pine has increased during the last few years and many trees have grown 2 to 3 feet in height each year. Redcedar appears to be growing vigorously but more slowly than the pines. The hardwoods, however, are failing. Many of them have survived on the better site, but they are much shorter than the pines. Their form is generally poor.

On the poorer site the amount of topsoil left greatly affected height growth of two hardwoods. On the severely eroded portions, yellow-poplar and ash average about 2.6 feet in height, but where there is 5 inches of topsoil the average height is 7.9 feet for yellow-poplar and 4.8 feet for ash. The pines and redcedar on the other hand grew about the same throughout the plots.

Central State Forest Expt. Sta., FS, USDA, Columbus, Ohio.

Broadfoot, W. M., and Krinard, R. M. EVALUATING SWEETGUM SITES. Southern Forest Expt. Sta. Occas. Paper 176, 8 pp. 1959.

Studies at the Stoneville Research Center have established 3 practical methods of estimating the ability of Midsouth soils to grow sweetgum (*Liquidambar styraciflua*). The methods were developed from data collected from 104 sweetgum plots.

The choice of method is a matter of individual preference. All three methods give site potential (site index) in terms of the height, in feet, that a free-growing forest tree will have reached at the age of 50 years.

In one study, the total height of trees at age 50 years was related to 37 chemical and physical properties of the soil. The two properties that proved most closely related, clay content and amount of exchangeable potassium, form the basis for evaluating sweetgum sites in the first method.

The second method provides rapid on-the-spot classification of sites by observation of surface drainage and determination of soil texture, internal drainage, and presence or absence of hardpan. This method is applicable only in the lower Mississippi Valley.

A third method requires that soils be mapped or otherwise identified by standardized series and phase, after which sweetgum site index can be read from a table.

Tables, charts, and graphs.

Southern Forest Expt. Sta. FS, USDA, New Orleans, La.

Gibbs, C. B. MANAGING A SMALL FOREST IN EAST TEXAS. Southern Forest Expt. Sta. Occas. Paper 163, 7 pp. 1958.

America's demand for timber is increasing. The U. S. Forest Service estimates that the market for wood will double before the century is out. Much of the timber to supply the mills of the future will come from small tracts, for more than half the nation's forested area is in holdings of less than 5,000 acres. Today's small-tract owner has a better opportunity than ever before to make money by growing trees.

Most small woodlands are producing only a fraction of their potential income--and those in east Texas are no exception. To gain information that would aid forest managers in this region, a tract on the Stephen F. Austin Experimental Forest was designated as a farm forest in 1947. It contains 67 acres. In size, it is thus very close to the 65-acre average for the forested portions of small landownerships in east Texas.

Results of Management: Pine growth on the forest ranged from 106 to 220 board feet per acre annually. It varied from compartment to compartment, being influenced not only by the pine stocking, but also by the density of competing hardwoods.

In 1947 the pine volume on the entire tract was 222,894 board feet. By 1957 it had increased to 243,552 board feet. This increase of 20,658 board feet, plus 92,875 board feet that were harvested, brings the total growth to 113,533 board feet for the ten years of management.

All timber was sold as stumpage. In addition to the pine logs, the sales included hardwood sawlogs and ties and some pine pulpwood fenceposts. The annual harvests rarely amounted to more than a half-dozen truckloads.

The gross returns from stumpage sales have been nearly $2,800, or $4.15 per acre annually. Pine logs brought 8 times as much per thousand board feet as hardwood logs. With ties included, the harvests contained as much hardwood as pine, yet the income from the hardwoods was less than $400. The quality of the hardwoods could be improved under management on most of the tract, but pines are much more profitable.

From these gross returns must be subtracted the costs of managing the forest. Most of the outlaws were for labor. Three and one-half man-days per year were devoted to controlling undesirable hardwoods and planting pine. Marking and scaling the harvests, controlled burning, and related activities took another 2-1/2 man-days annually. Taxes and supplies were additional expenses. The average for all costs was 95 cents per acre annually. Net yearly cash returns from management, thus have been $3.20 per acre.

These net returns do not fully measure the benefits from management. The increase in pine growing stock is worth about 80 cents per acre annually, so that the total net returns have been about $4.00 per acre each year.

Southern Forest Expt. Sta., FS, USDA, New Orleans, La.

Filip, S. M., Marquis, D. A., and Leak, W. B. DEVELOPMENT OF OLD-GROWTH NORTHERN HARDWOODS ON BARTLETT EXPERIMENTAL FOREST--A 22-YEAR RECORD. Northeastern Forest Expt. Sta. Paper 135, 7 pp. 1960.

Northern hardwood forests provide the industries of New England with their most valuable woods: yellow birch and sugar maple for veneer, paper birch for turning stock, and other hardwood species for a variety of specialty products. As a result of recent developments in hardwood pulping, these northern hardwood forests now represent a tremendous reservoir of raw material to the pulp and paper industry. To ensure a continued and balanced supply of timber for these wood-using industries, foresters must be well-equipped with information on the growth and development of northern hardwoods.

The available literature on growth of northern hardwoods is concerned largely with stand behavior during the first few years after cutting. In contrast, this report describes the development of undisturbed old-growth northern hardwoods over an average period of 22 years (range of 19 to 25 years). The information is based on records from 50 permanent 1/4-acre cruise plots located on the Bartlett Experimental Forest in New Hampshire--a 2,600-acre tract that is fairly typical of many hardwood forests in New England.

The plots were established in 1931 to 1932. Remeasurements were taken in 1939-40 and again in 1950-58. The two growth periods 1931-39 and 1940-58 are used as the basis for the data and discussion.

This information on the development of an unmanaged northern hardwood stand and its component species gives some indication of the growth potential of these forests, as well as the need and opportunities for skillful management. Depending upon the objectives of the owner, appropriate cutting methods may vary widely. But success under any system will depend to a large extent upon accurate evaluation and full consideration of the tolerance, longevity, and relative growth rates of each major species.

Northeastern Forest Expt. Sta., FS, USDA, Upper Darby, Pa.

Gilbert, A. M., and Jensen, V. S. A MANAGEMENT GUIDE FOR NORTHERN HARDWOODS IN NEW ENGLAND. Northeastern Forest Expt. Sta., Sta. Paper 112, 22 pp. 1960.

Northern hardwood forests occupy about 9 million acres of land in New England. In recent years, these hardwood forests have made increasing contributions to the economy of this region. Their future management should be even more rewarding.

This guide has been prepared for use in managing the old-growth and second-growth northern hardwoods of New England. It is intended to help chart the course of management for the initial cutting cycles on previously unmanaged forests. The suggestions presented summarize the results of 25 years of research on the Bartlett Experimental Forests, Bartlett, New Hampshire, and elsewhere in the region.

Northeastern Forest Expt. Sta., FS, USDA, Upper Darby, Pa.

Perry, J. D., and Guttenberg, S. SOUTHWEST ARKANSAS' SMALL WOOD LAND OWNERS. Southern Forest Expt. Sta. Occas. Paper 170, 13 pp. 1959.

Seventy-eight percent of southwest Arkansas' 8.9 million acres is timberland.

About 3.4 million wooded acres are in tracts of less than 5,000 acres in size, held by 55,000 owners. The average holding is 62 acres.

The individuals who tend to invest in forestry have above-average assets. Instead of contributing their own time, they typically hire labor for forest operations.

Active managers make up less than 10 percent of the owners but hold one-third of the acreage.

Planting open areas to pine and removing undesirable trees are the most popular practices. Sixty percent of those who plant and 84 percent of those who control weed trees receive government payments.

An estimated 7,000 owners in possession of over half a million acres are interested in leasing their tracts to obtain full professional management--a promising approach.

Public and private forestry agencies have stimulated good intentions among two-thirds of the region's landowners. Community leaders are confident that a sizable share of these intentions are ready to be converted to practice.

Agencies wishing to stimulate management on small holdings will probably accomplish most by first concentrating their resources on tracts of more than 99 acres.

Southern Forest Expt. Sta., FS, USDA, New Orleans, La.

Dortignac, E. J., and Love, L. D. RELATION OF PLANT COVER TO INFILTRATION AND EROSION IN PONDEROSA PINE FORESTS OF COLORADO. Trans. ASAE 3(1): 58-61. 1960.

The Rocky Mountain infiltrometer was used to evaluate infiltration and erosion of the most common vegetation cover types found in the ponderosa pine forests of Colorado. Almost 750 tests were conducted at the Manitou Experimental

Forest under grazed conditions. One-third as many tests were made elsewhere in the South Platte River watershed and on the Roosevelt National Forest, west of Loveland, Colorado.

On the basis of these tests, it was found that infiltration rates varied with cover type. Large pore space of the upper 2 in. of the soil and the quantity of dead organic materials were the two properties that accounted for most of the variation in the infiltration rates among cover types.

Erosion indices also varied with cover type, but soil origin and the amount of exposed or bare soil were the main factors affecting erosion.

Infiltration rates increased 1.31 in. per hour in grassland and 1.10 in. per hour in pine-grass after 14 years of protection from grazing at Manitou Experimental Forest.

Infiltration and erosion indices measured with the infiltrometer in the range pastures were compared with rates computed from adjacently located runoff plots. Even though measurements were made at different locations in the Manitou Experimental Forest, infiltration and erosion determined with the infiltrometer compared favorably with results obtained on runoff plots for similar plant-soil conditions.

Criteria are proposed for determining satisfactory infiltration rates and acceptable quantities of erosion in the ponderosa pine forests of Colorado utilizing results from infiltrometer tests and runoff plots.

Rocky Mountain Forest and Range Expt. Sta., FS, USDA, Fort Collins, Colo.

Parker, J. SEASONAL CHANGES IN COLD RESISTANCE OF SOME NORTHEASTERN WOODY EVERGREENS. J. Forestry 59: 108-111. 1961.

A program of study of cold resistance was undertaken at Yale to determine, among other things, how much variation in hardiness there was among some common woody plant species and how this hardiness changed with the season.

The authors summarize their work as follows:

1. By means of cooling and warming twigs with attached leaves in a temperature-controlled apparatus, hemlock (Tsuga canadensis), laurel (Kalmia latifolia), and white pine (Pinus strobus) were found to have characteristic rates of hardening in autumn. Pine hardened most rapidly, laurel next, and hemlock most slowly.
2. In summer, hardiness was about the same for all species, namely, about -8° C.
3. Young leaves of all species were resistant to at least -80° C. in midwinter using slow rates of cooling and warming. A single sample of white pine was cooled to -189° C. in March without apparent damage.
4. In spring, hemlock began to deharden earliest although all species rapidly dehardened when substantially warm weather arrived.
5. The more shaded individuals of laurel never developed the deep winter hardiness of the open-grown plants and had a lower sugar content than the latter.
6. Two-year-old hemlock leaves were much less resistant to cold than the youngest leaves in midwinter, but were generally hardier than the youngest leaves in summer. This difference was unrelated to sugar content.
7. Rates of cooling and warming were found to be quite important to levels of resistance measured, so that rates of cooling and warming should be specified.
8. Killing of laurel and some branches of hemlock and pine in the field as well as seedlings in nurseries was observed in the winter of testing. This was believed to be the result of winter drying brought on by frozen soil and frozen xylary water together with a certain amount of transpiration.
9. The role of temperature in determining northern limitations of forest trees is discussed. Although winter drying appears to be a more serious cause of damage than direct cold, the latter can cause serious difficulty to exotics and on rare occasions even to native plants.

Yale U. School Forestry, New Haven, Conn.

Williams, R. D. GROWTH AND YIELD OF A THINNED SHORTLEAF PINE PLANTATION. Central States Forest Expt. Sta. Tech. Paper 169, 12 pp. 1959.

In 1951, a stocking density study was established in a 14-year-old shortleaf shortleaf pine plantation in southern Indiana. Twelve plots were thinned to three different densities of basal area per acre: 80 square feet, 100 square feet, and 120 square feet. Four plots were left unthinned as checks. In 1958, the thinned plots were thinned again to the same residual basal areas.

Diameter growth was greatest on plots thinned to 80 square feet, but basal area growth was slightly greater on unthinned plots. However, there was little difference in diameter or basal area growth of 100 crop trees per acre, regardless of thinning intensity. Neither was there any apparent difference in height growth due to thinning intensity.

Volume growth was best on the unthinned plots. In the seven years after thinning, these plots produced 5 cords more wood per acre than the heavily thinned plots. Therefore, if thinning is delayed beyond 14 years, better tree form and accelerated volume growth will result in a bigger cut. Also, products cut will be more valuable.

Fomes annosus, a root rot, occurred in the medium and heavily thinned plots the sixth growing season after thinning. If F. annosus becomes widespread and no control is found, future plantings may have to be made on a wider spacing to make early thinning unnecessary. The importance of this disease needs evaluation.

Hardwoods were invading all plots, regardless of thinning intensity. But larger trees were more numerous near the edges of the plantation and on heavily thinned plots. Heavy thinning in young stands may stimulate severe hardwood competition long before the pine is ready for the harvest cut.

The data indicates that, if shortleaf pine plantations on similar sites are left unthinned until at least 20 years old, more and better products may be expected.

Central States Forest Expt. Sta., FS, USDA, Columbus, Ohio.

Skilling, D. D. GROWTH OF SWAMP CONIFERS FOLLOWING AN IMPROVEMENT CUT. Lake States Forest Expt. Sta. Paper 71, 10 pp. 1959.

A growth study of the first 10-year period following partial cutting of a swamp conifer stand brought out the following information:

1. Total production in both cords and basal area was greatest for those plots with the heaviest residual stand density (approximately 180 or more square feet of basal area). Growth, however, was relatively good for all stand densities sampled. Although the lower density plots showed less total growth, this was placed on fewer and better formed trees, which in part offset their lower production.
2. Diameter growth for the three principal species ranged from 0.5 to 1.2 inches for the 10-year period, with the larger trees on the less dense plots showing the most growth.
3. Wind losses due to partial cutting were negligible, although at least one severe windstorm hit the study area during the 10-year period.
4. The partial cutting in 1947 was evidently not heavy enough to establish reproduction over 3 feet tall in advance of a second cutting. Although considerable reproduction was present in 1957 on all stocking levels below 210 square feet per acre, this reproduction was in the 0- to 2-foot class. Browsing by snowshoe hare was a further factor in limiting white-cedar reproduction.

Lake States Forest Expt. Sta., FS, USDA, St. Paul, Minn.

Heinselman, M. L. WIND-CAUSED MORTALITY IN MINNESOTA SWAMP BLACK SPRUCE IN RELATION TO CUTTING METHODS AND STAND CONDITIONS. Soc. Amer. Foresters, Proc. pp. 74-77, 1957.

Windfall has long been recognized as a major cause of mortality in black spruce (Picea mariana (Mill.) B.S.P.). However, in spite of considerable experience with the wind problem, uncertainty over the effect of cutting practices on wind losses remains a deterrent to the application of silvicultural measures. Mortality records from a new cutting methods study in Minnesota is reviewed to provide a better basis for evaluating the windthrow risk.

The mortality records at Big Falls cover only the first 5 years since cutting, but this period represents the critical years for regeneration in the even-aged systems, and half a cutting cycle in the all-aged systems. Several windstorms have occurred providing a good comparative test of windfirmness of various types of stands under the several systems. The following conclusions seem warranted for previously uncut swamp stands growing on more than 1 foot of peat and otherwise similar to those studied:

1. Residual stands left after clear-cutting in strips or patches do not suffer substantially more wind loss than uncut or lightly partial-cut stands when the area cut constitutes about 20 percent of the total. This was true with strips 1 chain wide and patches $\frac{1}{4}$ to $\frac{1}{2}$ acre in size.
2. Wind-caused mortality increases with intensity of partial cutting, but it may not be appreciably greater than in uncut timber until 30 to 40 square feet of basal area per acre are cut.
3. In partial cuttings wind losses also increase with decreasing residual basal area, but there may be no important increase until stocking is reduced below about 85 square feet per acre.
4. Wind losses are greater on good sites than on poor. This may be due to the larger size of trees on good sites and to differences in peats, rooting characteristics, and the development of butt rot.
5. Losses increase with stand age. Increases in butt rot and in tree size with age probably contribute to the trend. The danger point varies but stands over 120 years of age are appreciably more susceptible to stem breakage, especially on good sites.
6. The effect of storm winds can be accentuated by large open areas such as recent clear-cuttings. Openings on the west side of stands are particularly hazardous.
7. Only the combination of heavy partial cutting in old timber on good sites and exposure on the west produced serious windfall at Big Falls.
8. Wind mortality does not seem to be a barrier to either the tree selection systems. This does not necessarily mean that these systems are effective with black spruce in obtaining reproduction or maintaining good growth.
9. The data indicate that light partial cuttings can be made in young stands without appreciably increasing wind mortality. Wind losses were at a minimum in the uncut stands. Since wind was the major cause of mortality, it seems unlikely that total mortality can be reduced to any extent by thinning.

Lake States Forest Expt. Sta., FS, USDA, St. Paul, Minn.

Heinselman, M. L. NATURAL REGENERATION OF SWAMP BLACK SPRUCE IN MINNESOTA UNDER VARIOUS CUTTING SYSTEMS. U. S. Dept. Agr., Forestry Serv., Prod. Res. Rpt. 32, 22 pp. 1960.

Black spruce (*Picea mariana* (Mill.) B.S.P.) occurs extensively in the peat bogs and swamps of northern Minnesota, where it is an important pulpwood tree. Natural regeneration is relied on, but a comprehensive test of possible cutting systems has not been reported. The first results of such a test on the Big Falls Experimental Forest, 4 to 6 years after the initial logging are reported. A summary of the literature and of older station studies is included to explore the evidence and draw conclusions on silvicultural aspects. Application of this knowledge rests with land managers who will need to consider economic and other factors in addition to the questions discussed here.

At Big Falls the cutting systems under test include several approaches to both even-aged and all-aged management. The even-aged systems are clear cutting in strips, clear cutting in patches, and shelterwood cutting. All-aged management is being attempted with tree selection and group selection cuttings. There also are light thinnings and uncut check areas. From this project, and from previous studies the following conclusions are drawn:

1. Overstories influence regeneration through their effect on heat, light, competition for water and nutrients, seedbed conditions, seed supplies, and other factors. When seed is available, the initial catch of seedlings can be good either in the open or beneath a moderate overstory, but subsequent survival and height growth are much better in the open.
2. Slow-growing Sphagnum, disturbed peat and moss on skidroads, and burned duff are good seedbeds. Feather mosses, Dicranum, and raw litter are poor. Fast-growing Sphagnum engulfs and kills seedlings.
3. Stocking of advance growth may vary from less than 10 percent to over 90 percent. Much advance growth is of layer origin, poor in form and vigor. Clear cutting destroys 30 to 50 percent of small advance stems. Advance reproduction should be regarded as an adjunct to new seedlings rather than a solution to restocking problems.
4. Slash covers seedbed with litter and buries advance growth when stands are clear cut. About 10 years are required for natural disappearance of slash. Slash burning or removal increases seedbed area and improves seedling distribution when a seed source is retained and shorten the period of restocking.
5. Seedling establishment is best on medium sites. Poor sites restock well, but the proportion of layers is high. Restocking is poorest on good sites. Site index is not an adequate guide for distinguishing between these "most difficult" and "less difficult" good sites.
6. Density of Ericacea, speckled alder, and raspberry increases rapidly after clear cutting.
7. All-aged management might succeed on poor sites where stands tend to be open and regeneration by layering is abundant. On better sites, the tree selection system is not promising because reproduction apparently cannot make satisfactory growth beneath the overstories that must be retained. Group selection may succeed if the stand openings are enlarged to the point where they approach patch clear cuttings.
8. Even-aged management is the most promising approach in swamps of the type studied. Systems of clear cutting in strips or in patches are effective because they provide an open area within seed dispersal range. When combined with slash burning or removal these systems permit the establishment of new seedlings, give maximum release to advance growth, and free the new generation from overstory competition. Shelterwood cutting is also effective, but more hazardous from the windfall standpoint. Black spruce, growing in the swamp habitats of northern Minnesota, is adapted to even-aged management. It remains to be seen whether all-aged stands can also be developed.

FS, USDA, Inform. Div., Washington 25, D. C.

Tepper, H. B., and Bamford, G. T. HARDWOODS ON POORLY DRAINED SITES DO NOT RESPOND TO LOW THINNING. Northeastern Forest Expt. Sta. Forest Res. Note 92, 3 pp. 1959.

Little is known about the effects of thinning upland hardwoods in southern New Jersey. To supply some of this needed information, State foresters have established several thinning studies. This research note reports the results of two of these studies, both located in stands of the pin oak-sweetgum type. One study was in Salem County, the other in Cumberland County.

The authors concluded that low thinnings made in 45- and 47-year-old hardwoods on moderately productive, poorly drained sites in southern New Jersey did not increase the 10-year growth of either the entire stand or of selected crop trees. Where desirable stems were already dominant, low thinnings did not improve stand composition.

Northeastern Forest Expt. Sta., FS, USDA, Upper Darby, Pa.

Engle, L. G., and Clark, F. B. NEW RODENT REPELLENTS FAIL TO WORK ON ACORNS AND WALNUTS. Central States Forest Expt. Sta. Note 138, 2 pp. 1959.

Direct seeding with repellent-treated coniferous seed has been successful in some regions. But the same chemicals failed to repel rodents from oak and black walnut seed in recent trials in southern Indiana. Although the chemicals failed to reduce rodent pilferage we found that proper timing of seeding may increase chances of seedling establishment.

The test area was a half-acre opening made in an oak-hickory stand. Rodents, especially chipmunks and squirrels, were abundant. Seeds were planted in the spring and fall of 1958 and the spring of 1959. Stratified seed was used in the spring plantings. Acorns were planted 1 inch deep and walnuts 2 inches deep. A total of 2,700 seeds were used in the trials.

Seeds planted in the spring of 1958 were coated with wheat paste slurries containing either (a) endrin or (b) thiram. Seeds planted in the fall of 1958 and spring of 1959 were coated with acrylic binders containing either endrin or thiram. Untreated seeds of each species were also planted in each test as checks.

The combined results of all trials show that the chemicals failed to reduce rodent pilferage.

Pilferage by rodents appeared to be related to mast production and this probably accounts for the difference between years.

Although direct seeding is cheaper than planting, direct seeding acorns and walnuts is still a gamble. But the risk might be less if seeding were done in the spring with stratified seed following a year of good mast production.

Central States Forest Expt. Sta., FS, USDA, Bedford, Ind.

Grelen, H. E. MECHANICAL PREPARATION OF PINE PLANTING SITES IN FLORIDA SANDHILLS. Weeds 7(2): 184-188. 1959.

Along the lower Coastal Plain, from the western panhandle of Florida to the Carolinas, lie approximately ten million acres of deep sands. In northwest Florida the sandhills support chiefly scrub oaks and wiregrass (Aristida stricta). Oaks are mainly turkey oak (Quercus laevis) and bluejack oak (Q. incana). Once an understory to longleaf pine (Pinue palustris), the scrub oaks gained dominance as heavy, indiscriminate logging removed the pines. Today only scattered pines remain, and the oaks and wiregrass prevent seed from these pines from restocking the area.

Sandhill soils have inherently poor moisture-holding capacity, and the water table is so deep that roots cannot penetrate to it. The shallow topsoil, sharply delineated by its darker color, goes down only 6 to 8 inches. In this shallow layer, feeder roots of all plants concentrate in a mat so dense that pine seedlings cannot successfully compete for moisture and nutrients.

An early study of mechanical methods of site preparation indicated that complete removal of all vegetation from planting sites increases pine seedling survival. However, growth differences--as between bulldozed and rootraked plots--emphasized the necessity for leaving as much as possible of the thin layer of sandhill topsoil.

In 1955, a new site-preparation study was installed to compare several machines and methods in current use by private companies. This paper reports the second-year results.

The authors conclude that at present, the best known method of preparing pine planting sites in the west Florida sandhills is clearing with a heavy, tandem double-drum brush chopper. This machine, with drums set at counteracting oblique angles to the line of pull, practically eliminates scrub oak and wiregrass competition while leaving the topsoil on the planting site. Vegetative debris also remains in place, contributing to the organic content of the soil.

Adequate survival of slash pine seedlings can usually be obtained by methods that provide a denuded planting site. If the topsoil is removed, however, satisfactory growth cannot be expected.

Southern Forest Expt. Sta., FS, USDA, New Orleans, La.

Lynch, D. W. EFFECTS OF A WILDFIRE ON MORTALITY AND GROWTH OF YOUNG PONDEROSA PINE TREES. Intermountain Forest and Range Expt. Sta. Res. Note 66, 8 pp. 1959.

Young ponderosa pine trees can withstand considerable fire damage without serious mortality. Their resistance appears to be superior to that of older trees of the same species for a given amount of crown injury. Fire is somewhat selective in its killing effect: it kills the smaller, weaker trees in greater proportion than the larger, more vigorous components of a stand. This characteristic has been cited as evidence in support of prescribed burning as a tool for thinning in dense, young stands.

Results of this study on 200 trees burned in 1949 was summarized as follows: (1) Virtually all mortality occurred during the first 2 years following the fire. (2) Mortality was directly related to crown injury: (a) all trees died whose crowns were 90 percent or more burned, and (b) mortality was only 6 to 24 percent when less than 80 percent of the crown was burned. (3) Small trees suffered greater mortality than large trees having the same degree of burn. (4) Second-year mortality was restricted to trees smaller than 6 inches d.b.h. except where crown injury had been 80 percent or greater. Second-year mortality probably was related more closely to bole injury than to crown injury. (5) Crown injury of 50 percent or more appeared to have reduced diameter growth in trees 6 to 9 inches d.b.h. And (6) height growth was not affected by burning.

Intermountain Forest and Range Expt. Sta., Ogden, Utah.

Morris, W. G. INFLUENCE OF SLASH BURNING ON REGENERATION, OTHER PLANT COVER, AND FIRE HAZARD IN THE DOUGLAS-FIR REGION (A PROGRESS REPORT). Pacific Northwest Forest and Range Expt. Sta. Res. Paper 29, 49 pp. 1958.

Stocking of coniferous seedlings (commercial species) established after logging and 6 inches or more in height did not differ significantly on plots of burned and unburned slash in the part of the Douglas-fir region that was studied.

In the Cascades, such seedlings did not attain the "medium" stocking class until about the sixth or seventh growing season after the slash fire.

On burned plots, stocking in the coastal area significantly exceeded that in the Cascades. On unburned plots, stocking in the coastal area was likewise greater than in the Cascades, but the difference was not statistically significant.

The few available coastal plots reached "medium" stocking by the third year and "good" stocking by the fourth year or soon thereafter.

On unburned Cascade plots, the number of postlogging seedlings growing on patches of exposed mineral soil exceeded that on equal areas of other surface materials. On coastal plots, seedlings grew with equal frequency on either class of seedbed.

Ground surface in which mineral soil made up a large or exclusive component appeared on 50 percent of the area of burned plots but on less than half as much of the unburned plots.

Quantities of several classes of fuel left on burned compared to unburned plots showed that burning: (1) Eliminated practically all branches bearing fine twigs; (2) reduced size of spots in which wood, rotton wood, and other fuels almost completely covered the ground and thinned out fuels on other such spots; (3) eliminated some spots of lesser concentration of fuel; and (4) charred but did not appreciably reduce volume of logs over 11 inches in diameter, but many logs did burn in two where they crossed, and this shortening and rearrangement reduced hazard.

Brush (shrub) crowns covered a greater part of unburned than of burned ground for at least 5 to 7 years after burning. In the Cascades, in the fifth season, the crowns covered about 10 percent of the ground on the average burned plot and about 20 percent on the unburned plot. They increased slowly after the third season following burning. In the coastal area they covered more ground than in the Cascades.

Herb foliage covered about the same proportion of area on burned and unburned ground. In the Cascades, herbs covered about 30 percent of the area by the fourth season and changed little in the next few seasons. In the coastal area, they covered a greater percentage of the ground.

Vine maple and Pacific rhododendron grew more densely on unburned ground, but snowbrush ceanothus grew more densely on burned ground. Species composition of brush cover differed on Cascade and coastal plots.

In the Cascades, the perennial fireweed and trailing blackberry predominated in the herbaceous cover on a large proportion of the pairs of plots and showed no preference for either burned or unburned ground. Woodland groundsel on burned ground and autumn willowweed on either burned or unburned ground sometimes predominated one year but nearly dissappeared the next.

In the coastal area, western swordfern from the original forest cover predominated in the herbaceous cover on several plots and appeared more frequently on unburned than on burned ground.

Estimated rate of spread and resistance to control for a fire on unburned plots exceeded that on burned plots for five seasons or more after the slash fire.

Pacific Northwest Forest and Range Expt. Sta., FS, USDA, Portland, Oreg.

* SILVICAL CHARACTERISTICS OF ** Central States Forest Expt. Sta. Misc. Release ***

*	**	***
Williamson, M. J.	EASTERN RED CEDAR.	15, 14 pp. 1957.
Merz, R. W.	OHIO BUCKEYE.	16, 12 pp. 1957.
Sander, I. L.	NORTHERN RED OAK.	17, 15 pp. 1957.
Merz, R. W.	SHELLBARK HICKORY.	18, 14 pp. 1957.
Brinkman, K. A.	BLACK OAK.	19, 14 pp. 1957.
Minckler, L. S.	PIN OAK.	20, 10 pp. 1957.
Minckler, L. S.	WHITE OAK.	21, 18 pp. 1957.
Brinkman, K. A.	BLACK WALNUT.	22, 15 pp. 1957.
Funk, D. T.	HONEYLOCUST.	23, 14 pp. 1957.
Limstrom, G. A.	CHINKAPIN OAK.	24, 11 pp. 1958.
Clark, F. B.	SWAMP WHITE OAK.	25, 10 pp. 1958.
Merz, R. W.	AMERICAN SYCAMORE.	26, 20 pp. 1958.
Deitschman, G. H.	BUR OAK.	27, 18 pp. 1958.
Clark, F. B.	BUTTERNUT.	28, 9 pp. 1958.
Carmen, W. H.	YELLOW BUCKEYE.	29, 16 pp. 1958.
Roach, B. A.	BLACK LOCUST.	30, 15 pp. 1958.
Krajicek, J. E.	HACKBERRY.	31, 11 pp. 1958.

These 15 silvical papers briefly summarize knowledge concerning the distribution, habitat conditions, life history, special features, and genetic factors of the designated tree species.

Central States Forest Expt. Sta., FS, USDA, Columbus, Ohio.

* SILVICAL CHARACTERISTICS OF ** Lake States Forest Expt. Sta. Paper ***

*	**	***
Rudolf, P. O.	RED PINE (PINUS RESINOSA).	44, 32 pp. 1957.
Heinselman, M. L.	BLACK SPRUCE (PICEA MARIANA).	45, 30 pp. 1957.
Scholz, H. F.	ROCK ELM (ULMAS THOMASI).	47, 16 pp. 1957.
Strothmann, R. O., and Zasada, Z. A.	QUAKEN ASPEN (POPULUS TEMULOIDES).	49, 26 pp. 1957.
Godman, R. M.	SUGAR MAPLE (ACER SACCHARUM).	50, 24 pp. 1957.
Roe, E. I.	TAMARACK (LARIX LARICINA).	52, 22 pp. 1957.
Guilkey, P. C.	AMERICAN ELM (ULMUS AMERICANA).	54, 19 pp. 1957.
Neinstaedt, H.	WHITE SPRUCE (PICEA GLAUCA).	55, 23 pp. 1958.
Scholz, H. F.	SLIPPERY ELM (ULMUS RUBRA).	59, 14 pp. 1958.
Rudolf, P. O.	JACK PINE (PINUS BANKSIANA).	61, 31 pp. 1958.
Scholz, H. F.	AMERICAN BASSWOOD (TILIA AMERICANA T.).	62, 17 pp. 1958.
Slabaugh, P. E.	BIGTOOTH ASPEN (POPULUS GRANDIDENTATA).	63, 16 pp. 1958.

Roe, E. I.	BALSAM POPULAR (*POPULUS BALSAMIFERA*).	65, 17 pp. 1958.
Slabaugh, P. E.	BLACK MAPLE (*ACER NIGRUM*).	66, 9 pp. 1958.
Godman, R. M.	NORTHERN WHITE CEDAR (*THUJA OCCIDENTALIS*).	67, 17 pp. 1958.

These 15 silvical papers briefly summarize knowledge concerning the distribution, habitat conditions, life history, special features, and genetical factors of the designated tree species.

Lake States Forest Expt. Sta., FS, USDA, St. Paul, Minn.

* SILVICAL CHARACTERISTICS OF ** Northeastern Forest Expt. Sta. Paper ***

*	**	***
Leak, W. B.	SWEET BIRCH (*BETULA LENTA*).	113, 14 pp. 1958.
Little, S.	ATLANTIC WHITE CEDAR (*CHAMAECYPARIS THYOIDES*).	118, 16 pp. 1959.
Little, S.	PITCH PINE (*PINUS RIGIDA*).	119, 22 pp. 1959.
Hart, A. C.	BALSAM FIR (*ABIES BALSAMEA*).	122, 22 pp. 1959.
Wright, J. W.	WHITE ASH (*FRAXINUS AMERICANA*).	123, 19 pp. 1959.
Hart, A. C.	RED SPRUCE (*PICEA RUBENS*).	124, 18 pp. 1959.
Wright, J. W.	GREEN ASH (*FRAXINUS PENNSYLVANNIA*).	126, 18 pp. 1959.
Snow, A. G., Jr.	VIRGINIA PINE (*PINUS VIRGINIANA*).	131, 22 pp. 1960.
Hough, A. F.	EASTERN HEMLOCK (*TSUGA CANADENSIS*).	132, 23 pp. 1960.
Gilbert, A. M.	YELLOW BIRCH (*BETULA ALLEGHANIENSIS*).	134, 18 pp. 1960.

Each of these silvical papers briefly summarize knowledge concerning the distribution, habitat conditions, life history, special features, and genetical factors of the designed tree species. The following additional five papers will be published from this station: beech, paper birch, black cherry, red maple, and eastern white pine.

Northeastern Forest Expt. Sta., FS, USDA, Upper Darby, Pa.

* SILVICAL CHARACTERISTICS OF ** Pacific Northwest Forest and Range Expt. Sta. Paper ***

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Worthington, N. P.	RED ALDER.	1, 15 pp. 1957.
Stein, W. I.	CALIFORNIA-LAUREL.	2, 16 pp. 1958.
Berntsen, C. M.	WESTERN-HEMLOCK.	3. 1958.
Dimock, E. J., II.	PACIFIC SILVER FIR.	4, 12 pp. 1958.
Staebler, G. R.	NOBLE FIR.	5. 1958.
Tarrant, R. F.	PACIFIC MADRONES.	6, 16 pp. 1958.
Hayes, G. L.	PORT-ORFORD-CEDAR.	7. 1958.
Ruth, R. H.	SITKA SPRUCE.	8, 19 pp. 1958.
Isaac, L. A., and Dimock, E. J., II.	DOUGLAS-FIR.	9, 18 pp. 1958.
Silen, R. R.	OREGON WHITE OAK.	10, 13 pp. 1958.
Dahms, W. G.	MOUNTAIN HEMLOCK.	11, 8 pp. 1958.
Sowder, J. E., and Mowat, E. L.	WESTERN JUNIPER.	12, 9 pp. 1958.
Ruth, R. H., and Muerle, G. F.	BIGLEAF MAPLE.	13, 10 pp. 1958.

A series of station releases that brings together the existing knowledge of the range, habitat conditions, and life history of 13 important forest trees in the Pacific Northwest.

Pacific Northwest Forest and Range Expt. Sta., FS, USDA, Portland, Oreg.

Sucoff, E. I., and Church, T. W., Jr. SEED PRODUCTION AND DISSEMINATION BY VIRGINIA PINE. J. Forestry 58: 885-888. 1960.

The seeding characteristics of Virginia pine were studied on the Beltsville Experimental Forest, Laurel, Md., and on two stands near Springfield, W. Va. Seed dissemination from the north, east, south, and west edges of an uncut block of 35-year-old pine was measured from 1952 through 1954. Annual seedfall from many stands, including four seed-tree cuttings and two strip-cuttings, was sampled beginning in 1950. Observations were made on the annual variations in seed production among stands and trees. The time during which Virginia pine seed falls from the cone was examined.

The results of these studies are: (1) Most Virginia pine seed is distributed by the prevailing winds; most falls within 100 feet of the stand in which it is produced. (2) A shortage of good seed-producing trees can be offset only in part by leaving more seed trees per unit of area. (3) During the period 1950 to 1958, the best seed years were 1950, 1953, 1957, and 1958. (4) Release of Virginia pine trees may stimulate seed production. (5) Variations in seed production among individual Virginia pine trees and stands are often great. The best guide to future seed production by individual trees is their past production. And (6) Virginia pine seed begins to fall in late October and continues until the following May. Most of the sound seed falls during October, November, and December.

Northeastern Forest Expt. Sta., Laurel Res. Cent., FS, USDA, Laurel, Md.

Mann, W. F., Jr., and Burkhalter, H. D. THE SOUTH'S LARGEST SUCCESSFUL DIRECT-SEEDING. J. Forestry 59: 83-87. 1961.

During the winter and spring of 1958-1959, T. L. James & Company direct-seeded 18,545 acres in central Louisiana in a venture which may serve as a milestone for southern foresters. This article records the story and outcome, for it is the biggest successful direct-seeding project in the South to date.

The large and successful project in Louisiana clearly shows that direct-seeding is a valuable reforestation technique for the South. It will not replace tree planting entirely, but it will give landowners greater flexibility and economy in regenerating depleted lands.

Both planting and seeding have certain limitations. On adverse sites where first-year survival may be poor, planting should be relied on exclusively. Conversely, direct-seeding is better adapted to sites with heavy stands of hardwoods or logging debris. Areas like the one discussed in this paper lend themselves either to planting or seeding, and landowners must reach a decision by considering the costs and risks of both methods.

The Company successfully seeded for about half the cost of planting, and with a capital outlay of about 25 percent of that needed for planting. Moreover, the labor force was substantially smaller, and training and supervisory problems simpler. The risks were about the same, for direct-seeding is reliable if recommended procedures are carefully followed.

Southern Forest Expt. Sta., FS, USDA, New Orleans, La.

Derr, H. J., and Mann, W. F., Jr. GUIDELINES FOR DIRECT-SEEDING LONGLEAF PINE. Southern Forest Expt. Sta. Occas. Paper 171, 22 pp. 1959.

In the past few years, direct seeding of longleaf pine has moved from the exploratory stage to full operational use. This achievement culminates a dozen years of intensive study of a forest regeneration technique that has long intrigued foresters by its apparent simplicity.

Direct sowing of pine has been especially appealing to owners of the cutover longleaf lands, where seed trees are usually inadequate for natural regeneration, and where planting of this species is unreliable. Wide acceptance of direct seeding as a method of restocking longleaf land promises to keep this valuable species in the pine forests of the South.

Since 1947, when the first direct-seeding test was installed by the Alexandria Research Center, 19 field-plot and pilot-stage studies have been completed. While these dealt with all aspects of the topic, the principal objective was control of seed losses to birds and mammals. After a 1953 study demonstrated that a chemical seed coating would repel birds, progress was rapid. In the past four years, Louisiana landowners have seeded 42,300 acres on 31 separate projects.

The research and field trials on which these guidelines are based were completed entirely within the longleaf pine type in central and southwestern Louisiana. Direct seeding can probably be used to regenerate longleaf pine throughout its natural range. However, variations in climatic or biotic conditions may require some modification of the procedures developed in Louisiana. For example, when rodents are a limiting factor, effective chemicals for their control must be included in the seed coating. Where soil conditions are adverse, such as in the Florida sandhills, very intensive site preparation may be essential. Geographic variations in the amount and distribution of rainfall can alter the sowing dates or seedbed treatments recommended for Louisiana conditions. Trials east of the Mississippi River should include local study of the factors affecting seed losses, seed germination, and initial survival. Results from a single test should be interpreted with caution. Variations in the biological factors involved, together with fluctuations in the climatic influences from year to year, will often necessitate several years of testing before the necessary modifications in techniques for a local area are apparent.

Southern Forest Expt. Sta., FS, USDA, New Orleans, La.

Gratkowski, H. EFFECTS OF HERBICIDES ON SOME IMPORTANT BRUSH SPECIES IN SOUTHWESTERN OREGON. Pacific Northeast Forest and Range Expt. Sta. Res. Paper 31, 33 pp. 1959.

A series of screening tests were established during 1955 to determine the effects of six commercial and experimental herbicides on brush in southwestern Oregon. The herbicides were tested as foliage sprays on 13 of the most abundant species and varieties of brush on forest lands in this area. Low volatile esters of 2, 4-D and 2,4,5-T proved to be the most effective herbicides.

Results of the tests show that the 13 brush species and varieties can be classified into three categories on the basis of degree of susceptibility to foliage applications of herbicides: (1) Highly susceptible; (2) moderately susceptible; and (3) resistant.

Highly susceptible--Four species proved very susceptible to herbicides and were readily killed with low concentrations of 2,4-D in water. Species in this group were hairy manzanita, hoary manzanita, Howell manzanita, and deerbrush ceanothus.

Moderately susceptible--Aerial parts of 3 species and 1 variety were readily killed with chemicals, but relatively few of the shrubs were completely killed. Most of the treated plants resprouted the year after treatment. This group included greenleaf manzanita, snowbrush ceanothus, varnishleaf ceanothus, and mountain whitethorn ceanothus. The 2,4,5-T was most effective on the ceanothus, whereas 2,4-D was most effective on greenleaf manzanita.

Resistant--Three species and two varieties proved resistant to herbicides. Only parts of the stems and branches died back after being sprayed with herbicides; none of the treated plants were killed. In the resistant group were golden chinkapin, golden evergreenchinkapin, scrub tanoak, saskatoon serviceberry, and canyon live oak. The chinkapins were most affected by 2,4,5-T. There was little difference, however, between the effects of 2,4-D and 2,4,5-T on tanoak and serviceberry. On canyon live oak, 2,4-D was more effective than 2,4,5-T.

A list of suggested spray solutions based on results of the screening tests are presented in tabular form.

Pacific Northwest Forest and Range Expt. Sta., FS, USDA, Portland, Oreg.

Leaf, A. L., and Smith, R. E., Jr. HERBICIDAL VALUE OF ARSENIC TRIOXIDE IN EASTERN UNITED STATES. Weeds 8(3): 374-378. 1960.

The herbicidal effectiveness of As_2O_3 in Eastern United States varied with type and rate of arsenic application, type of vegetation, and soil moisture, drainage and texture. The toxic effect of non-dusting powder As_2O_3 was greater for grasses and herbaceous plants than woody vegetation three years after treatment. The toxicity of As_2O_3 was greater on coarse than fine textured soils, and on wet compared to well-drained soils (Table).

State U. Col. Forestry, Syracuse U., Syracuse, N. Y.

TABLE .--Degree of herbicidal effect three years following treatment, and minimum effective rate of non-dusting powder AS_2O_3, on New Hampshire, West Virginia, and Georgia plots.

Area	Vegetation	Soil	Herbicidal effect*	Minimum effective rate of As_2O_3 + 2% $CaCl_2$ lb/A	Remarks
New Hampshire	Herbaceous-woody	Acid, sandy loam	Slight	2200	Slight kill of grass and herbaceous vegetation.
	None, (bare soil)	Acid, sandy loam	High	1200	70-80% plot area bare of vegetation.
West Virginia	Woody-herbaceous	Acid, loam to clay loam	Slight	2000	Slight kill of herbaceous vegetation, patchy effectiveness.
		Acid, loam to sandy loam	High	2000	60-95% plot area bare of vegetation, woody vegetation least affected.
	Woody-herbaceous (mowed)	Acid, loam to clay loam	Moderate	2000	Patchy effectiveness, greater toxicity on wetter or poorly drained portions of plots.
		Acid, loam to sandy loam	High	2000	60-95% plot area bare of vegetation, woody vegetation least affected.
Georgia	Dense woody and grass	Acid, sand	High	1000	Most positive toxicity of this study, 95-100% plot area bare of vegetation.

*Herbicidal effect more pronounced on wet or poorly drained sites.

Peevy, F. A. METHODS OF APPLYING HERBICIDES FOR CONTROLLING INDIVIDUAL WEED TREES. Forests and People 9(3): 31, 42-43. 1959.

Results from recent tests show that injection of 2,4,5-T at the base of trees with a tree injector is an efficient method of killing weed trees. It can be used throughout the year on a variety of woody species. Susceptible species of southern upland hardwoods, under 9 inches in diameter, usually die within a few months after treatment, and all sizes usually die within two years.

A suitable herbicidal solution can be made by mixing 12 to 20 lbs. of 2,4,5-T per 100 gallons of diesel oil. Space injections 2 inches apart, edge to edge, around the base of the trunk near the ground of red, post, blackjack, and white oaks under 9 inches in diameter and 1 inch apart for trees over 9 inches in diameter. For hard-to-kill species such as sweetgum, blackgum, elm, willow, water oak, and hickory, space injections 1 inch apart for stems under 9 inches in diameter and ½ inch apart for those over 9 inches in diameter. Fill incisions with the solution. The cost of treating hardwoods with 2,4,5-T ranged from one-fourth to one-third cent per inch of stem diameter, the cost depending on density of stand, concentration of herbicidal solution, and the spacing of injections. The application of herbicides with a tree injector was slightly more expensive than application in girdles made with a mechanical tree girdler. However, the injector was safer to use, and better sprout control was obtained from this method of application.

Fenuron was more effective for control of blackjack and post oak than other herbicides as soil applications. Good kill was obtained when this material was applied at rates of ½ to 1 gram per inch of stem diameter during late winter and spring. The cost ranged from one-half to three-fourths cent per inch of trunk diameter.

CRD, ARS, USDA, Alexandria, La.

Peevy, F. A. FOLIAR APPLICATION. Forests and People 9(2): 20-21, 46. 1959.

Tests on control of woody plants by ground foliar application of herbicides with several types of spray equipment were started at the Alexandria Research Center in 1945. Two additional experiments for aerial application of herbicides were initiated in 1957 and 1958 in cooperation with Louisiana State University, private landowners, and the Kisatchie National Forest.

Results show that foliar application of herbicides is effective for controlling woody plants growing in dense stands where single-stem treatments are not feasible, and aerial application has proved to be a fast and effective method of treating large areas covered with dense stands of trees. Herbicides may be applied with ground equipment, such as hand sprayers, small portable power sprayers, or power sprayers mounted on trucks or tractors. Common compressed-air hand sprayers are suitable for low brush on small areas, if pressures of 25 lbs. per square inch (PSI) or greater are used. Pressure for power sprayers varies with the type of equipment used. Pressure for power sprayers varies with the type of equipment used. All spraying should be done according to State regulations.

For foliar treatment from the air, 2 lbs. of acid equivalent of low-volatile ester of 2,4,5-trichlorophenoxyacetic acid (2,4,5-T) per acre in an oil-water emulsion, consisting of 3.5 gallons of water and 1.5 gallons of oil and herbicide, is the most effective and economical treatment. This herbicide is more effective on a wider range of species that grow on southern upland forest land than other herbicides tested. It is also effective on most species that are controlled by other herbicides.

Dense stands of southern hardwoods may require an initial application of 2 lbs. per acre of 2,4,5-T ester followed the succeeding year by 1 or more lbs. of 2,4,5-T. For the initial application in large-scale operations, 2 lbs. of 2,4,5-T ester can be applied at a cost of $7.50 to $9 per acre. Costs will vary with location, size of the area, and type of equipment being used.

Foliar applications made with ground equipment are useful for controlling brush on small or isolated areas that cannot be treated efficiently by aerial application. Also, foliar applications made from the ground are useful for control of brush where over-story conditions do not warrant or permit other methods of chemical control.

Two to four lbs. of acid equivalent to low-volatile ester of 2,4,5-T per 100 gallons of carrier, made up of 98 gallons of water and 2 gallons of oil and herbicide, is an effective treatment for applying to woody plants with ground equipment. Species such as blackjack oak, post oak, red oak, sweetgum, black gum, hickory, and myrtle can be controlled successfully when stems do not exceed 15 feet in height.

Spraying one hundred gallons of material containing 4 lbs. of 2,4,5-T ester will cost approximately $12 per acre under present prices. Cost will vary with the concentration of herbicide used, volume applied, and type of equipment used. Retreatment should be delayed a full growing season after initial application so that enough new growth will be available to receive a good dose. All spraying should be done in such a manner that there will be some overlapping of sprayed area at the outside edge of the spray patterns.

CRD, ARS, USDA, Alexandria, La.

Rogers, N. F. AIRPLANE-SPRAYED HERBICIDES RELEASE SHORTLEAF PINE FROM HARDWOODS. Central States Forest Expt. Sta. Note 117, 2 pp. 1958.

Application of herbicides from an airplane is a satisfactory and relatively cheap method of releasing shortleaf pine from competing low-quality hardwoods. Pine grows among or under hardwoods on several million acres in Missouri. Many sites are better suited for growing pine than hardwoods. Many of the hardwoods have little or no potential value.

Cutting or girdling the competing hardwood trees is costly and usually provides only temporary release because of profuse sprouting from the stumps. Applying herbicides by hand in frills or on stumps is also expensive but this method results in greatly reduced subsequent sprouting.

The studies were made in oak-pine stands where the pine trees ranged from less than 1 to more than 50 feet in height. The much more numerous hardwood trees ranged in size from dense sprout reproduction and saplings to dominating cull sawlog trees.

A 5-gallon solution of 2 lbs. of either 2,4,5-T or 2,4,5-TP acid and fuel oil was applied by air to each acre in June and early July.

The herbicides were equally effective, causing an average of 90 percent defoliation of the hardwood trees during the first growing season. About half these trees died after 2 years. Although many sprouts have developed on the living trees, the trees are low in vigor and many will probably die in the next few years.

No pine trees were killed by the herbicides but some of the needles, as many as 75 percent on some trees, turned reddish-brown and fell off. In every case, however, new needles developed during the same growing season. On areas released by aerial spray, the pines grew 50 percent more during the second growing season than similar unreleased pines.

Contract costs of aerial spraying vary with the size and location of the operation, the cost of materials, and competition among contractors. In these studies, treatment cost $7.75 per acre on a 40-acre tract and $4.92 per acre on an area of 800 acres. Comparable release by hand methods would cost from $12.50 to $25.00 per acre.

Central States Forest Expt. Sta., FS, USDA, Columbus, Ohio.

McConkey, T. W. HELICOPTER SPRAYING WITH 2,4,5-T TO RELEASE YOUNG WHITE PINES. Northeastern Forest Expt. Sta. Paper 101, 14 pp. 1958.

A helicopter application of 2,4,5-T was made on two areas of the Massabesic Experimental Forest in 1954. Rates of 1 and 3 lbs. acid equivalent in enough fuel oil to total 2-1/2 gallons per acre were used.

Both rates of application killed the hardwood overstory (mostly oak). Results of the treatment indicate that birch and white oak can be controlled readily with such treatments; that fair control of red oak can be expected; that although red maple can be severely damaged, it is rarely killed; and that sweet fern is readily killed but new root suckers replace the original growth.

Effects on white pine were beneficial. White pine is relatively resistant to 2,4,5-T, and the occasional damaged young tree recovers. White pine shows a good response to release after hardwoods are controlled by these treatments.

It is not possible to make good comparisons between 1- and 3-lb. applications of 2,4,5-T per acre because of the differences between the stands on the two areas treated.

Northeastern Forest Expt. Sta., FS, USDA, Upper Darby, Pa.

Quigley, K. L., and Mitchell, G. H. HOW OHIOANS CHOOSE THEIR CHRISTMAS TREES. Central States Forest Expt. Sta. Tech. Paper 163, 7 pp. 1959.

Many things influence consumers' preferences for Christmas trees. These include such tangibles as species, price, grade, and appearance as well as such intangibles as custom or family background.

Almost 40 percent of the 600 consumers interviewed said they preferred Scotch pine for their Christmas tree. Of the species on display, red pine was considered the least desirable Christmas tree. Most consumers buy a tree because of its appearance, needle-holding ability, or because of family tradition.

About two-thirds of the Christmas tree users interviewed preferred a premium-grade tree. However, if the premium-grade tree costs much more than the other trees, almost one-fifth of the buyers who prefer the premium-grade tree would switch to a lower grade tree.

With Christmas tree production constantly increasing, Christmas tree producers need to carefully consider their market and the kind and species of trees they are producing. They need to observe consumers' expressed preferences and guide their production accordingly.

Central States Forest Expt. Sta., FS, USDA, Columbus, Ohio.

TABLE 1.--How Consumers Rate Various Species of Christmas Trees
(In percent)

Tree species	Most desirable	2nd choice	Least desirable
Scotch pine	38	25	7
Balsam fir	25	21	21
Norway spruce	19	23	22
White pine	10	18	17
Red pine	8	13	33
Total	100	100	100

Metz, L. J., and Douglass, J. E. SOIL MOISTURE DEPLETION UNDER SEVERAL PIEDMONT COVER TYPES. U.S. Dept. Agr. Tech. B. 1207, 23 pp. 1959.

Data are presented on soil moisture observed under forest cover, old-field vegetation, and bare soil. The authors summarize the results as follows: (1) The withdrawal and recharge of soil moisture is cyclic, repeating itself each year. Recharge begins in the late fall or winter, and depletion begins with the start of the growing season, continuing until late fall. During dry years, the soil may not be recharged to field capacity. (2) Recharge from summer precipitation adds moisture to the soil surface layers beneath vegetation; however, even for very heavy rains, the water is quickly used by evapotranspiration, so that for all practical purposes it does not move below 30 inches. Low infiltration rates limit the recharge of soil moisture of barren eroded soils. (3) Depletion of soil moisture lends itself to curvilinear analysis by depths or profile and cover types. Forest types appear to deplete soils of moisture to depths of at least 66 inches at relatively the same rate regardless of species. Under old-field herbaceous vegetation and bare soil, moisture is lost primarily from the surface 30 inches, although slight losses occur at greater depths. And (4) moisture loss from barren and vegetated soils is related to depth. With increasing depth of soils, the rate of moisture loss decreases. Under vegetation this is a reflection of root concentration, while from bare soils it is a reflection of the characteristics of evaporation from soil.

FS, USDA, Inform. Div., Washington 25, D. C.

Stoeckeler, J. H., and Curtis, W. R. SOIL MOISTURE REGIME IN SOUTHWESTERN WISCONSIN AS AFFECTED BY ASPECT AND FOREST TYPE. J. Forestry 58: 892-896. 1960.

Soil moisture in the top 2 feet of soil was significantly higher in a north-facing than in a south-facing slope on five different sampling dates along a transect in native timber across an east-west valley near La Crosse, Wis., in 1957. It was about twice as high on the north as on the south slope.

On the north slope there was a regular and systematic increase in soil moisture from top to bottom of the slope. On the south-facing slope the trend also appeared but was less consistent because of presence of shallow ledge rock on the upper third of the slope and the recharge effect of the runoff from that zone on the middle third of the slope.

The moisture content under a northern hardwood forest on a north slope was almost double that under a white pine plantation on the same aspect.

But in stands located on south-facing slopes, moisture content in a Scotch pine plantation was fairly similar to that in native oak woods. Since the volume growth in the pine plantation was 3.5 times as high as in the scrubby oak stand, type conversion on the drier slopes by reforestation would seem to be a means of greatly increasing timber production on the farm-woods in the area.

Lake States Forest Expt. Sta., FS, USDA, St. Paul, Minn.

Wilbur, E. C. BETTER WOODLAND THROUGH WATER CONTROL. Soil Conserv. 26: 43-44. 1960.

The Lower Neches Soil Conservation District in southeastern Texas has taken the lead in showing how water control can be applied to woodlands where excess water is a major problem in the production of wood products.

There are 527,000 acres of woodland in the Lower Neches district, mostly in private ownership. A recent conservation needs survey showed that excess water was a major problem on approximately 409,000 acres, or 70 percent of the total agricultural land in the district.

The Dishman-Lucas Estate became a cooperator with the district in February 1957. The complete soil and water conservation plan developed by SCS technicians and Mr. Lucas included a water control system for the 2,260-acre woodland tract.

Prior to 1957, this woodland tract was a cutover stand of mixed hardwoods and scattered pine. Surface water covered most of the tract for 4 to 5 months out of the year to a depth of 6 to 8 inches. Natural pine reproduction was drowned out and planting of seedlings was impractical.

Logging operations were hazardous and expensive because of flooding. The pine, gum, and other merchantable species were showing little or no growth.

The intensity of water control needed on woodland is not nearly as great as on cropland. Primary ditches were spaced from 1,000 to 1,300 feet apart. Internal drainage developed naturally and laterals were used only where there was an obvious need.

Since the water control system was installed on the Dishman-Lucas woodland tract in July 1958, many benefits have been noted. The main advantages noted were: (1) Dirt removed in ditching operations were piled in such a manner that openings are left approximately every 100 feet, permitting lateral movement of water into the ditches. (2) Water control makes it practical to install woodland management practices and increases accessibility for logging operations. (3) The ditches serve as excellent firebreaks and divide the woodland acreage into workable management blocks or compartments. (4) The water control work has benefited wildlife. Removal of surface water has improved the natural habitat for wildlife by providing better sources of food and cover for all kinds of native wildlife. Ducks, particularly mallards and woodducks, are attracted to natural ponds in the woodlands which have acorns, cypress seeds, smartweeds, and other kinds of desirable food. And (5) the most important benefit of water control, however, is that it makes possible the growing of a better class of timber.

SCS, USDA, Rosenberg, Tex.

Eschner, A. R. EFFECT OF SCRUB OAK AND ASSOCIATED GROUND COVER ON SOIL MOISTURE. Northeastern Forest Expt. Sta. Paper 133, 16 pp. 1960.

Planting experiments have been conducted for the past 10 years in the scrub oak type at the Delaware-Lehigh Experimental Forest in eastern Pennsylvania to find a practical method of establishing a high forest of greater value than the area's present cover. In the course of these studies, it was suggested that soil moisture might be a limiting factor in seedling survival and growth; so a study was made to determine soil-moisture conditions under the components of the scrub oak stand.

The scrub oak type extends over a large area of eastern Pennsylvania. It is a temporary type that became established as a result of, and is maintained by, repeated fires. It consists of a mixture of low growing shrubs and tree sprouts; primarily scrub oak (Quercus ilicifolia, Wangenh), sheep laurel (Kalmia angustifolia, L.), huckleberry (Gaylussacia spp. Hbk.), and blueberry (Vaccinium spp. L.); and includes American chestnut (Castanea dentata (Marsh.) Borkh.), sassafras (Sassafras albidum (Nutt.) Nees), red maple (Acer rubrum L.), northern red oak (Quercus rubra L.), white oak (Quercus alba L.), and pitch pine (Pinus rigida Mill.). Bracken fern (Pteridium aquilinium (L.) Kuhn) is a common member of the community.

Soil moisture was sampled in Hazleton stony 1 in eastern Pennsylvania on 29 dates in the summer and fall of 1957. Sampled during this period were three depths--0 to 6 inches, 6 to 12 inches, and 12 to 18 inches--and five cover types--bare, groundcover, scrub oak and groundcover, scrub oak, and undisturbed humus with deadened cover.

Significant differences were found in the amounts of water held in the soil under various cover conditions. Soil moisture was consistently highest on areas where the cover had been deadened (2,4,5-T in oil), and lowest under a mixed cover of scrub oak and ericaceous groundcover. In an 18-inch layer of soil, there was an average of 2.09 inches more soil moisture under the deadened vegetation than under the intact scrub oak and groundcover during the growing season, and 3.20 inches more during a drought. An area covered chiefly by sheep laurel generally had the second lowest soil-moisture content.

During a severe summer drought, differences between the two plots having the lowest soil-moisture contents were not significant except in the 0- to 6- and 12- to 18-inch layers. These differences are attributed chiefly to differences in root activity, but may be explained in part by the concentration of rainfall around scrub oak sprout clumps, caused by interception and stemflow. This gives higher soil-moisture contents to areas that are difficult to sample gravimetrically at the expense of areas that are more likely to be sampled. Thus, the measured soil-moisture content for the plot may be lower than the actual, but undetermined, soil-moisture content.

The soil-moisture content of the bare area from which the natural humus layer and several inches of topsoil had been removed was generally intermediate in rank. The consistently lower soil-moisture content in the 12- to 18-inch layer reflects its high bulk density.

A site treatment that completely deadens the low-growing vegetation but does not destroy the humus layer should be the most desirable for making maximum amounts of soil moisture available to planted seedlings. Deadening the scrub oak alone will not reduce transpiration losses any appreciable amount.

Northeastern Forest Expt. Sta., FS, USDA, Upper Darby, Pa.

McAlpine, R. G. FLOODING KILLS YELLOW POPLAR. Forest Farmer 19(3): 9, 13-14. 1959.

As more and more yellow-poplar seedlings are planted with varying success, it is apparent that site is of major importance in survival and growth. Abandoned farm lands--both field and pasture--seem to be the easiest and most logical planting sites, and it is a great temptation to plant yellow-poplar in these areas without regard for the species' silvical requirements.

For best growth, yellow-poplar needs abundant moisture and good drainage during the entire growing season. Low survival and poor growth rates have resulted from planting old fields where severe competition has contributed to the depletion of the already low soil moisture supply during dry periods of the summer.

Trees grow well on the edge of smaller creeks where summer flooding is frequent but of short duration. This indicates that the length of the flood period is important. A controlled study of season and duration of flooding of transplanted seedlings in small tanks has shown this to be true. Seedlings were able to withstand flooding during the growing season for 3 days with little mortality or loss of growth, but extending the period increased mortality until all were dead after 14 days.

Flooding injury to young yellow-poplar trees may give a clue to the conspicuous absence of this species in the lower areas of the bottom lands. Scattered mature trees are found almost without exception in areas which are elevated and, although occasionally flooded, drain quickly as the water recedes.

Usually, it is safe to plant on areas where yellow-poplar trees grow well in natural stands. Old fields along the smaller creeks are low hazard sites because overflows, though frequent, are of short duration.

Southeastern Forest Expt. Sta., FS, USDA, Asheville, N. C.

Halls, L. K., Hughes, R. H., and Peevy, F. A. GRAZED FIREBREAKS IN SOUTHERN FORESTS. U.S. Dept. Agr. Inform. B. 226, 8 pp. 1960.

Grazed firebreaks are open strips of improved pasture with a twofold value. First, they help to stop or slow down the spread of forest fire, provide a strip from which to backfire when making prescribed burns or attacking wildfires, and serve as access roads for deployment of men and equipment. Second, they benefit livestock and game by producing good forage during a large part of the year and by providing a means of getting increased use of native plants in the woods.

These improved-pasture strips have certain advantages over the plowed or burned firebreaks commonly used in the South. They are less likely to erode than plowed lines and, if closely grazed most of the year, they have less flammable fuel than burned breaks. Moreover, grazing values compensate for the loss of timber production on the breaks.

Guides for establishing and maintaining grazed firebreaks are furnished. It is directed particularly to southern forest landowners interested in coordinated production of timber, cattle, and game.

Recommendations are applicable to the Norfolk-Ruston, Coxville-Portsmouth-Bladen, and Leon-Bladen soil associations in the longleaf-slash and shortleaf-loblolly pine types. In this region rainfall is usually abundant and well distributed over a long growing season. The three main soil areas are generally suitable for forage production, but differ slightly in requirements for grazed firebreak construction and maintenance.

FS, USDA, Inform. Div., Washington 25, D. C.

Halls, L. K. COORDINATION OF CATTLE GRAZING AND TIMBER GROWING ON SOUTHERN COASTAL PLAIN FORESTS. Soc. Amer. Foresters, Salt Lake City, Utah, Proc. pp. 192-195. 1958.

Longleaf and slash pine forests can grow livestock and timber at the same time, and thus contribute more to the economy than if managed for a single product. Coordination of these products, however, encompasses a multitude of factors ranging from personal attitude and managerial ability to basic understanding of the reproduction, growth, and management of livestock, forage, and timber.

Current management practices are geared mainly towards timber, but recent grazing tests show that native forage of Coastal Plain pine lands can be utilized efficiently by cattle. Compatible dual-use requires minimizing grazing damage to young pines, securing proper seasonal distribution of cattle, providing an adequate year-round grazing and feeding program, periodically burning the rough to reduce fire hazard and promote growth of higher quality forage, regulating timber stand density to insure healthy growth of trees and reasonable forage production, and controlling undesirable plants that compete with timber and forage.

Southern Forest Expt. Sta., FS, USDA, New Orleans, La.

Lemin, A. J., Klomparens, W., and Moss, V. D. TRANSLOCATION AND PERSISTENCE OF CYCLOHEXIMIDE (ACTI-DIONE) IN WHITE PINES. Forest Sci. 6: 306-314. 1960.

The antifungal antibiotic cycloheximide (Acti-dione) is absorbed by, persists in, and is translocated upward in pole-size western white pine. The antibiotic persists for at least 2 years in the trunk bark of western white pine treated by the basal stem method. Cycloheximide was applied only to the lower trunk area and later recovered from needles of unsprayed branches. Movement was through the water-conducting elements, for the antibiotic could be detected in xylem tissue both at and above the site of application but was never detected in bark (phloem) tissue above the treated area of the trunk.

Cycloheximide was also found to be translocated to needles on untreated branches of eastern white pine.

Agr. Res. and Development Div., Upjohn, Co., Kalamazoo, Mich.

Thatcher, R. C. INFLUENCE OF THE PITCH-EATING WEEVIL ON PINE REGENERATION IN EAST TEXAS. Forest Sci. 6: 354-361. 1960.

Studies in east Texas during 1955-58 showed that pine weevil populations were composed primarily of the pitch-eating weevil. The adults burrow down to stump roots, where they lay eggs. Broods develop in 6 to 11 months, depending on the season in which they become established. Adults may emerge at any time during the growing season.

On plots where overstory pines were cut within 3 months of the time pine seedlings were planted, weevil feeding resulted in heavy mortality of planted loblolly, shortleaf, and slash pine seedlings; natural seedlings of comparable size were also attacked. Damage was much less on areas cut in July before planting in January, and negligible on areas cut in April or earlier. Incidence of attack did not significantly vary with pine species.

The most severe weevil attack and seedling mortality occurred between March and June. Following 2 months (July, August) of relative inactivity, weevils resumed feeding until late November, but caused negligible seedling mortality.

All spring feeding was by adults drawn into recently cut plots from other areas. Late fall feeding, however, was apparently by adults newly emerged from roots of stumps on plots cut the previous fall, winter, and spring.

Damage to seedlings during their first year from seed was negligible.

It is concluded that in east Texas: (1) Pine seedlings may safely be planted on areas cut earlier than the previous July. A longer wait may be necessary in the more northerly portions of the southern pine range. (2) Seedlings to be planted on areas from which pine has been cut within 6 months should be protected by chemical treatment. (3) Advance reproduction 1 or 2 years old may suffer heavy mortality. One or two years' delay in cutting may enable such seedlings to outgrow their vulnerability. And (4) regeneration cuts may be made during seed years with little fear of excessive losses from weevils.

Southern Forest Expt. Sta., FS, USDA, Nacogdoches, Texas.

Woods, F. W., Harris, H. C., and Caldwell, R. E. MONTHLY VARIATIONS OF CARBOHYDRATES AND NITROGEN IN ROOTS OF SANDHILL OAKS AND WIREGRASS. Ecology 40(2): 292-295. 1959.

The sandhills of western Florida, now largely occupied by scrub oaks and wiregrass, are capable of growing good stands of pine. Soil moisture is the limiting factor for establishing seedlings in this area, however, and all competing vegetation must be eradicated before pines can be successfully planted or seeded. An inexpensive method of eradicating the oaks and wiregrass, therefore, would encourage landowners to restore these sites to timber production.

Tops of the oaks and wiregrass are relatively simple and cheap to destroy by fire or mechanical means, but little is accomplished by killing only the tops. Wiregrass generally responds to these treatments with profuse vegetative growth, and oak root collars sprout freely. The amount and intensity of initial sprouting is determined, presumably, by the abundance of reserve food stored in the roots. This study was designed to discover the time of year when carbohydrate and nitrogen root reserves of sandhills scrub oaks and wiregrass are lowest--and hence when these plants can be most efficiently destroyed.

In a 3-year study in the sandhills of western Florida, carbohydrate food reserves in the roots of turkey oak and bluejack oak reached their lowest annual ebb between late April and early May. The period of greatest depletion coincided with the time the new leaves were reaching full size. The major nitrogen depletion period of oaks corresponded generally with that of carbohydrates, but lasted until about the first week of June.

Roots of pineland three-awn grass were at their lowest level of carbohydrates in mid-July and of nitrogen in September. Fluctuations of both carbohydrates and nitrogen were much less pronounced than in the oaks.

Cutting the tops from oaks caused the carbohydrates of the roots to remain low for at least twelve weeks.

It appears that late April or early May is the best time to start eradication of the oaks. Eradication treatment at the time probably would be satisfactory for the grass (which is of secondary importance), even though the root reserves of the grass are somewhat lower in midsummer.

Southern Forest Expt. Sta., FS, USDA, New Orleans, La.

Leaf, A. L., and Madgwick, H. A. I. EVALUATION OF CHEMICAL ANALYSES OF SOILS AND PLANTS AS AIDS IN INTENSIVE SOIL MANAGEMENT. Fifth World Forestry Congress, Seattle, Washington, Aug. 29-Sept. 10, 1960. Sp 100-I-USA, 6 pp. 1960.

This review of soil and plant analysis shows that considerable more information on many aspects of growth and mineral nutrition of trees, and aspects of soils and fertilizers is necessary before an adequate method is found for predicting response to fertilizers. Now it can only be said that, below certain levels of soil and plant nutrients, deficiencies may be present.

Foresters have to rely on agriculture for much of their knowledge and, even with much larger resources for research, agriculturists are far from an adequate knowledge of plant growth and nutrition. It is only in recent years that a vigorous attempt has been made to work out some of the details of growth and mineral nutrition of different species of trees. Analysis of complete trees allows an estimation of the total uptake and distribution of nutrients within tree stands and overcomes the problems of selecting sampling position and expressing plant analyses purely on a concentration basis.

Unfortunately, interpretation of studies of complete trees is subject to many of the difficulties associated with plant analysis. There is no known way of differentiating between luxury consumption and uptake necessary for tree growth. Variability between trees is great so that adequate sampling of a stand requires analysis of several trees. The effect of species, soil characteristics, sampling season, translocation of nutrients and washing of leaves by precipitation, on the nutrient cycle are practically unknown.

The need for fundamental research on all aspects of tree nutrition is obvious. Now the most effective way to determine nutrient deficiencies is through fertilizer trials, but a judicious use of both soil and plant analyses prior to the establishment of such trials might well save foresters a considerable amount of wasted time and effort.

State U. Col. Forestry, Syracuse, U., Syracuse, N. Y.

Trappe, J. M., and Harris, R. W. LODGEPOLE PINE IN THE BLUE MOUNTAINS OF NORTHEASTERN OREGON. Pacific Northwest Forest and Range Expt. Sta. Res. Paper 30, 22 pp. 1958.

Lodgepole pine (Pinus contorta) is a major species in northeastern Oregon. The lodgepole type covers nearly 400,000 acres in the Blue and Wallowa Mountains, and individual trees are scattered over many of the remaining six million forested acres in this area. The type blankets large areas in watersheds in a region where spring floods and summer irrigation are vital factors in the economy. It also serves as a cover for game--grouse, snowshoe hares, deer, and elk. And, it is potentially important for lumber, poles, and pulpwood.

Before 1952, little use was made of this species in the Blue Mountains. There were occasional cuttings for poles or small sawtimber, but generally it was considered a weed, occupying land that should be supporting other trees or grass. Use of lodgepole pine in northeastern Oregon has been increasing in the last six years, however, and has focused attention on the lack of basic knowledge of its habits in the area.

To better understand establishment, development, and characteristics of lodgepole pine stands in the Blue Mountains, a study was started in 1956 by the Pacific Northwest Forest and Range Experiment Station in cooperation with the Pilot Rock Lumber Co. General results of the study are given.

Pacific Northwest Forest and Range Expt. Sta., FS, USDA, Portland, Oreg.

Fruit and Nut Crops

Kessler, G. M. BLUEBERRIES THRIVE ON "WASTE" LAND. Amer. Fruit Grower 80(5): 10-11, 34, 36. 1960.

In southwestern Michigan some 5000 acres of acid soil, once considered worthless, are today producing a $4 million blueberry crop.

The culture and care of blueberries in Michigan are discussed.

Mich. State U., East Lansing, Mich.

Holmes, R. S. EFFECT OF PHOSPHORUS AND pH ON IRON CHLOROSIS OF THE BLUEBERRY IN WATER CULTURE. Soil Sci. 90: 374-379. 1960.

To investigate the effect of varying acidity and P concentration in nutrient solutions on iron chlorosis of the blueberry, plants were grown in cultures in which the P ranged from 1 to 60 p.p.m. and the pH values were constant. Other plants were grown in cultures with varied pH values and constant P concentration. In the latter part of the growth of the plants an iron chelate (FeEDDHA) replaced the inorganic iron in all nutrients.

Plants grown in the low P nutrient at pH 4 showed signs of P deficiency and were only three-fourths as large as the plants grown on higher P treatments. The plants grown in the highest P nutrient showed signs of incipient iron chlorosis.

Plants in nutrient of pH 4 and pH 5 made the most growth. The plants grown at higher pH values increased in severity of Fe chlorosis and decreased in size with increase of pH values in the nutrient.

The contents of P and Fe in the leaves of blueberry plants varied with increased quantities of P in nutrients. The variations were most pronounced in the younger leaves. A high P content appears to have the effect of lowering the Fe content in a nutrient solution and thereby produces iron chlorosis in the blueberry plant.

The variation in the contents of P and Fe in the older leaves of plants in nutrients at varied pH showed little trend with treatment, but in the younger leaves the content of Fe decreased with the increase of pH in the nutrient. The maturity of the leaves should be considered in the diagnosis of iron chlorosis by an analysis of the Fe content of blueberry leaves.

With the substitution of FeEDDHA for the inorganic Fe in the nutrient, the chlorotic plants became green, and all plants continued to grow, flower, and produce ripe berries.

U. S. Mineral Nutr. Lab., SWCRD, ARS, USDA, Beltsville, Md.

Nixon, R. W. GROWING DATES IN THE UNITED STATES. U.S. Dept. Agr. Inform. B. 207, 50 pp. 1959.

Information on date culture in the Southwestern United States based on extensive research findings and grower experience is summarized. The date palm is very different from other fruit trees in cultural, climatic, and management requirements. Essential information for inexperienced growers, students of horticulture, home growers, and others interested in the production of this unique fruit crop is given. Date production increased from 1 million lbs. in 1926 to more than 48 million lbs. in 1955.

ARS, USDA, Inform. Div., Washington 25, D.C.

Whittenberger, R. T., and Hills, C. H. BRUISING OF RED CHERRIES IN RELATION TO THE METHOD OF HARVEST. U.S. Dept. Agr., Agr. Res. Serv., ARS 73-27, 14 pp. 1960.

Early studies showed that the bruising of red cherries during harvest is a primary cause of scald blemishes and other defects in cherries to be processed. Two new methods of harvest designed to reduce bruising have been tested and compared to the present commercial method. In the first, cherries were picked with the fingers and permitted to fall onto a self-draining fabric suspended on a frame beneath the tree. In the second, cherries were jarred or shaken manually from a tree onto the suspended fabric.

In the first method, bruising was reduced significantly and the rate of harvest increased slightly. In the second method, there was no change in bruising, and the rate of harvest increased about fourfold. Over-all results indicate that major improvements in the harvesting of cherries can be made without lowering quality.

ARS, USDA, Inform. Div., Washington 25, D. C.

Lamb, R. C., and Fisher, E. C. PEAR CULTURE. Cornell Ext. B. 977, 20 pp. 1960.

The major problem limiting pear production in New York during the past 30 years has been fire blight disease. Most pear orchards have been maintained in low vigor since this practice reduced the severity of the disease. Low vigor, however, produced low yields, and profits inevitably declined. Until recently, few new pear orchards were planted, and pear production in New York showed a steady downward trend from 1935 until the mid-forties.

Following the middle of the last decade, production decreased to such an extent that it did not meet demand and prices generally became favorable. As a result, some neglected orchards have recently been cared for and a few new ones planted. If pear prices remain satisfactory, pear plantings can again increase.

A consistant annual production of high quality pears is necessary to establish dependable markets. New York pears are generally of excellent quality. Maintenance of high annual yields and control of the fire blight damage are the major production problems.

This is a complete culture and care bulletin for pear growers.

Cornell Ext. Serv., N. Y. State Col. Agr., Ithaca, N. Y.

Baker, E. R. CRANBERRY PRODUCTION IN THE PACIFIC NORTHWEST. Soil Conserv. 26: 54-56. 1960.

Four years of hard labor, with an investment of around $3,500 an acre, are necessary before the first crop of berries is harvested from cranberry bogs in the Grays Harbor Soil Conservation District of western Washington.

This highly specialized crop is restricted to a small area in Pacific and Grays Harbor Counties, stretching along the beaches for nearly seven miles. This area produces 75 percent of Washington's cranberries.

Following the selection of a desirable site for a bog, it is cleared of all trees, brush, roots, and sedges before it can be leveled and prepared for planting. As the clearing and leveling progress, it is necessary to lay out and install a complete system of drainage ditches. These ditches serve a dual purpose of protecting the bogs from flooding during heavy rains and controlling the water table. An excess of water is injurious to the cranberry plants and excessive drainage causes a decomposition of the peat, which results in settling of a bog.

During the period following installation of the drainage system, most growers lay out a sprinkler irrigation system. The cranberry grower has a multipurpose use for his irrigation system. Water is stored in reservoirs and pumped over the entire bog through an overhead sprinkler system. This is done during dry weather and also during periods of extreme heat when the growing berries may become injured by heat scald. A more important use of the sprinkler system, however, is for protection from frost during early spring and late fall. The system is controlled thermostatically to turn on immediately as the temperature over the bog dips to 32 degrees. The fine spray over the vines prevents injury to the cranberries, even with temperatures as low as 24 degrees.

This type of irrigation system may cost as much as $1,000 per acre.

Following installation of the irrigation system, the field is prepared for planting. A small movable railroad track is laid the entire length of the bog to transport sand. The track is later installed permanently down the center of the bog. It is then used for spray equipment, resanding operations, fertilizing, and transporting the harvested crop to the warehouse.

During the slack seasons of early winter and spring the bog is thoroughly leveled. A layer of sand from three-quarters to one and one-half inches deep is applied. The uniform sand layer stimulates root growth of the plants. Cuttings of vines, obtained from local producing bogs, are then planted directly into the sand.

Following planting of the bog, there is a four- to five- year waiting period before the first crop is ready for harvest. During this period of slow plant growth and after production begins, there are continuous problems of management confronting the grower. Good management includes such practices as fertilization, weed control, pruning of vines, frost and heat control, insect and disease control, irrigation, and crop harvest. The success of these practices largely determines the life of a bog and its production over the years. A bog under good management may last a hundred years or more.

Over the years, through improvements in equipment and management, great strides in production have been made. The area under the management of one grower has increased from one or two acres in the early days to as high as 14 acres. Yields range from 75 to 300 barrels per acre. A barrel of cranberries weighs 100 pounds and sells for $12 to $13.

SCS, USDA, Montesano, Wash.

Shaulis, N. J., and Jordan, T. D. CULTURAL PRACTICES FOR NEW YORK VINEYARDS. Cornell Ext. B. 805 Rev., 35 pp. 1960.

New York ranks second among the 50 states in the production of grapes. The annual average production has been 82,000 tons since 1950. California leads in total production by a 30-fold margin, but none of the commercial varieties of either New York or California is important in the other state. Major areas producing varieties grown in New York are Washington, Canada, Michigan, Pennsylvania, and Ohio.

New York's grapes, of which Concord is the leading variety, are used for juice, jam, jelly, and preserves. In recent years, about five percent of New York's annual tonnage has been sold for fresh fruit or has been utilized at home; another five percent has been used commercially for pulped or de-seeded grape products; 20 percent has been sold directly to wineries; and the remaining 70 percent has been pressed as unfermented juice, some of which is later sold to wineries. Before 1920, more than three-fourths of the crop was sold as fresh fruit.

Grape acreage in New York has shown a steady decline from about 62,000 acres in 1930 to 31,000 acres in 1955, with the acreage estimated at about 29,000 acres at present. The average yields, however, have doubled to three tons per acre in recent years and total tonnage has not decreased. The only state that has recently increased its acreage of Concord or slip-skin grapes is Washington.

The greatest opportunity for expansion of New York's grape industry in the immediate future seems to lie in increasing the quantity of high quality grapes produced per acre. The technology is available to obtain a five ton per acre yield without reducing quality. The resultant tonnage increase probably would take care of normal market expansion.

The various cultural practices for grape growing in New York are explained.

Cornell Ext. Serv., N. Y. State Col. Agr., Ithaca, N. Y.

Cook, J. A. VINEYARD FERTILIZERS AND COVER CROPS. Calif. Agr. Expt. Sta. Ext. Serv. L. 128, folded. 1960.

Grapes are grown profitably in California on soils ranging from loamy sand to heavy clay and varying widely in fertility. However, production is highest and cultural problems least on medium to light soils that are deep and well drained. The grapevine does not have a high nutritive requirement. A high level of soil fertility is less important than having a soil of such physical nature that deep and extensive root development is promoted. Instances of deficiency of many fertilizer elements are rare, and only four have been shown to be of economic importance in California vineyards; these are nitrogen, potassium, and two micronutrients, zinc and boron.

It is very difficult to raise and permanently maintain soil organic matter at a higher level than existed in the native soil. The nitrogen supplied by an interplanted winter legume covercrop will very seldom exceed 20 to 25 lbs. per acre, and the cost of this much commercial nitrogen is much lower than the cost of producing the covercrop. Interplanting a covercrop may have an undesirable effect in vineyares because: (1) Irrigating the seed bed in the early fall may stimulate succulent vine growth just before frost; (2) in nonirrigated vineyards, careful timing is required as to how long the covercrop may be allowed to grow in the spring before affecting soil-water reserve for vine growth; and (3) plowing under a heavy, succulent, green manure crop in early spring may cause soil nitrogen to become very low just before the vines need it most, and then release the nitrogen back to the soil in rather large amounts just when the supply to the vines should be reduced. For these reasons the general recommendation is to plant covercrops only where breakdown of soil structure or plow sole development have created a water penetration problem, or where erosion must be controlled in hillside vineyards.

A common covercrop for the lighter soils of the San Joaquin Valley is a mixture of purple vetch and barley, planted annually in alternate middles. Vine prunings are thrown into the unplanted middles. About 20 lbs. of barley and 20 to 30 lbs. of purple vetch (Vicia atropurpurea) per acre are drilled in 4- to 8-foot strips. Planting is usually done soon after grape harvest and before the winter rains. If rains are late, a fall irrigation may be desirable for getting the covercrop off to an early start. Covercrops with a stemmy growth and a well-developed taproot--such as mustard or horsebeans--are best for heavy, fine-textured soils where improved water penetration is desired. Two covercrops that seem to be particularly suited to general vineyard use are subterranean clover (Trifolium subterraneum) and bur clover (Medicago hispida). Bur clover is more adapted to the sandy soils of the interior valleys. Both clovers are low-growing, self-seeding when properly handled, and add some nitrogen to the soil.

Summer Covercrops: In some irrigated table-grape vineyards, grasses and other plants are allowed to grow after early summer. If growth is excessive, the covercrop is mowed or cut with a rotary blade. The fruit remains relatively free from dust and sometimes ripens earlier, colors better, and ships better than fruit from clean-cultivated vineyards. These effects are greatest on shallow soils.

Calif. Agr. Expt. Sta. Ext. Serv., U. Calif., Berkeley, Calif.

Proebsting, E. L. FERTILIZERS AND COVERCROPS FOR CALIFORNIA ORCHARDS. Calif. Expt. Sta. Ext. Serv. C. 466, 19 pp. 1958.

An orchard fertilizer program must take into account the condition of the soil, the species of fruit, and any nutrient deficiency symptoms shown by the trees. Since all these factors vary with individual orchards, no quick and easy method is available for determining whether fertilizer is needed.

This circular suggests ways for finding out whether an orchard would profit by fertilization, describes nutrient deficiency symptoms, and indicates application methods.

Covercrops are discussed both as sources of organic material and as aids for maintaining good soil structure.

Here are the Principal Commercial Sources of Nitrogen for Orchards

Name	Compound formula	Percent nitrogen	Advantages	Disadvantages*
Anhydrous ammonia	NH_3	82	High nitrogen percentage; ease of application; no residue; little danger of leaching	(a) In irrigation water: Uneven distribution if irrigation system not adapted to its use. Cannot be used with sprinklers. (b) Dry injection: Some loss if ground is trashy or cloddy
Ammonia solution	NH_4OH	Usually 20	Easier to handle than anhydrous; no residue	Same as for anhydrous
Ammonium sulfate	$(NH_4)_2SO_4$	21	Acid residue (for alkaline soils); little danger of loss by leaching; ease of handling	Acid residue (for very acid soils). Delayed availability during nitrification
Ammonium nitrate	NH_4NO_3	33	High N percentage; no residue. Half immediately available, half delayed	
Ammonium phosphate-sulfate (16-20) mixture		16	Same as ammonium sulfate. Carries phosphate if needed for covercrop	Same as ammonium sulfate
Ammonium phosphate	$NH_4H_2PO_4$	11	High phosphate content where needed for covercrops	Low N percentage
Calcium nitrate	$Ca(NO_3)_2$	15.5	Calcium residue (for acid or high sodium soils). Immediate availability	May be leached
Urea	NH_2CONH_2	42	High N percentage. Is not fixed if irrigated at once, before conversion to ammonium carbonate. No residue	May be toxic in high concentrations
Sodium nitrate	$NaNO_3$	16	Alkaline residue (for acid soils); immediate availability	Sodium residue undesirable on high sodium soils. May be leached
Calcium cyanamide	$CaCN_2$	24	Alkaline residue (for acid soils). Calcium residue	Danger of burning, especially at high rates or in growing season

*There is no serious trouble with the physical properties of any of these materials unless they are stored too long or under poor conditions.

Annual covercrops may be divided into four groups: winter legumes, summer legumes, winter nonlegumes, and summer nonlegumes. Among winter legumes, the most widely grown are bitter clover or annual yellow sweetclover (*Melilotus indica*), the vetches, and bur clover. Horsebeans, fenugreek, lupine, and field peas have been successful in more limited areas. The following crops have had some use as summer legumes: cowpeas; velvet, mung, tepary, and mat beans; soybeans; sesbania; and Hubam clover. The most widely used winter nonlegumes are: mustards (common, black, and Trieste) and cereals (rye, oats, barley), together with volunteer weeds. Where summer nonlegumes are desired, orchardgrass, Sudangrass, and summer-growing weeds have proved satisfactory.

In addition to these crops, an increasing number of growers are using permanent sod. This system eliminates the cost of cultivation, and is the most effective check on erosion. It permits orchard operations when the soil is wet that are not feasible under clean cultivation. On the other hand, this method requires more water, increased use of nitrogen (even with a leguminous sod), and more rigorous efforts in pest control. It provides cover for mice and gophers. It is not suitable for species whose fruit is harvested from the ground--for example, prunes, almonds, walnuts, or figs. Alfalfa has been widely and successfully used for permanent sod, and perennial ryegrass has also proved satisfactory. In some areas, throughout the year, volunteer weeds provide a succession of plants which, though containing few perennials, serve adequately.

Calif. Agr. Expt. Sta. Ext. Serv., U. Calif., Berkeley, Calif.

Veihmeyer, F. J., and Hendrickson, A. H. ESSENTIALS OF IRRIGATION AND CULTIVATION OF ORCHARDS. Calif. Agr. Expt. Sta. Ext. Serv. C. 486, 28 pp. 1960.

The principles on which good irrigation and cultivation practices in orchards are founded are presented. The same principles also apply to other crops. Research conducted in California, has shown that: (1) Deciduous fruit trees need readily available moisture all year around, but no additional benefits are gained by adding more water to that already available; (2) beneficial results of good irrigation practices, such as increased yields, are cumulative and require many years to appear; (3) harmful results of poor irrigation practices, such as decreased fruit size, may show up immediately when trees are not supplied with readily available moisture; (4) large trees need no more water than small ones, as long as the area shaded by the leaves is the same; (5) cover crops in the orchard do not conserve soil moisture; and (6) withholding irrigation does not make the trees send down their roots more deeply into the soil.

Calif. Agr. Expt. Sta. Ext. Serv., U. Calif., Berkeley, Calif.

McCormick, L. FEATHER-BEDDING PECANS. Amer. Fruit Grower 80(6): 9, 25. 1960.

Eight miles south of Las Cruces, N. Mex., in the tiny community of Santo Thomas, Stahmann Farms, Inc., world's largest producer of pecans and white Chinese geese is located.

This "popular style" article describes the production and marketing of pecans from the 80,000 pecan trees and geese from the 275,000 raised on the farm. The geese are used for a better balanced farm program, and for a manure source.

No address given.

Field Crops

Bernstein, L. SALT TOLERANCE OF FIELD CROPS. U.S. Dept. Agr., Agr. Inform. B. 217, 6 pp. 1960.

This bulletin: (1) Explains how soil salinity affects field crops; (2) provides information on the salt tolerance of field crops; and (3) tells how to manage crops on saline soils.

TABLE .--The Salt Tolerance of Field Crops

Tolerant	Moderately tolerant	Sensitive
12 millimhos[1]	8 millimhos[1]	2 millimhos[1]
Barley (grain)[2]	Rye (grain)	Field beans
Sugar beet[2]	Wheat (grain)	
Rape	Oats (grain)	
Cotton (upland)	Sorghum (grain)	
	Sorgo (sugar)	
	Soybeans	
	Sesbania[2]	
	Broadbean	
	Corn	
	Rice[2]	
	Flax	
	Sunflower	
	Castorbean	
8 millimhos[1]	4 millimhos[1]	

[1] Electrical conductivity of saturation extracts of soil (EC_e) at which small losses in yield may be expected. For gypsiferous soils add 2 millimhos to these figures.

[2] See discussion on tolerance of germination and seedling stages of barley, sugar beet, Sesbania, and rice, p. 3.

Saline lands can be managed to minimize salt injury to field crops by: (1) Providing adequate drainage; (2) leveling carefully; (3) using appropriate planting practices; (4) irrigating often enough and adequately; and (5) selecting sufficiently tolerant crops.

ARS, USDA, Inform. Div., Washington 25, D. C.

Wilkinson, S. R., and Ohlrogge, A. J. INFLUENCE OF BIURET AND UREA FERTILIZERS CONTAINING BIURET ON CORN PLANT GROWTH AND DEVELOPMENT. Agron. J. 52: 560-562. 1960.

Seven greenhouse experiments were conducted to evaluate biuret injury to corn seeds and subsequent plant development. One field experiment involving 5 biuret contents in urea and 3 placements was completed in the summer of 1959, with the following results.

Biuret caused severe injury to growing corn plants. The observed biuret toxicity syndrome was as follows: (1) Interveinal chlorosis, generally appearing to be most chlorotic in immature leaves, or actively growing leaf regions; (2) abnormal leaf growth generally described as hyponastic and, in certain cases, a dying and dropping out of areas along the leaf margin; and (3) severe stunting of the corn plant resulting in death in the severest cases.

The toxicity of biuret in urea was influenced by the rate of application of biuret and apparently by the factors which influence the absorption of biuret by the corn plant. Placement of biuret away from the seed minimized the potential biuret injury hazard to germination and emergence of corn.

Crystalline urea did not produce any of the toxicity symptoms produced by biuret or biuret in urea.

Yield reductions due to biuret content and to placement were observed in a small field experiment.

Purdue U. Agr. Expt. Sta., Lafayette, Ind.

Crops Research Division. GROWING GRAIN SORGHUM. U. S. Dept. Agr. L. 478, 8 pp. 1960.

A "culture and care" bulletin on grain sorghum.

ARS, USDA, Inform. Div., Washington 25, D. C.

Jones, J. N., Jr., and Sparrow, G. N. PRINCIPLES OF TOBACCO IRRIGATION. U.S. Dept. Agr., Agr. Res. Serv., Agr. Inform. B. 228, 16 pp. 1960.

Many farmers are irrigating tobacco in order to insure satisfactory yields of a high-income crop. Inadequate rainfall or its poor distribution during the growing season reduces crop yield and quality. Even in years when rainfall is generally adequate but not ideally distributed, irrigation, properly applied at crucial stages of tobacco growth, can improve the quality of the tobacco and increase production of the leaf.

The general principles of irrigating tobacco are discussed.

ARS, USDA, Inform. Div., Washington 25, D. C.

Reitz, L. P., and Briggle, L. W. DISTRIBUTION OF THE VARIETIES AND CLASSES OF WHEAT IN THE UNITED STATES IN 1959. U. S. Dept. Agr., Agr. Res. Serv. Stat. B. 272, 83 pp. 1960.

Wheat growers have a large number of varieties from which to choose. New varieties become available from time to time. Experimental evidence, farm experience, and market demand affect the grower's choice. The extent to which acceptable varieties are being grown is of importance to the milling trade. In order to determine what farmers are growing, a wheat variety survey was conducted in 1959. This was similar to variety surveys conducted by the United States Department of Agriculture at 5-year intervals since 1919. Variety surveys provide a historical record of changes and serve as a basis for further wheat improvement.

The estimated acreages are presented, as determined from the ninth survey for wheat sown for the 1959 crop. The estimated acreages by varieties and by market classes were computed from the preliminary seeded acreages of wheat by crop-reporting districts, as estimated by the Agricultural Estimates Division, Agricultural Marketing Service.

Tables and maps.

ARS, USDA, Inform. Div., Washington 25, D. C.

Chandnani, J. J., Kavitkar, A. G., and Patel, A. S. STUDIES ON THE RESPONSE CURVE OF NITROGEN OF WHEAT SERIES V. J. Indian Soc. Soil Sci. 8(3): 181-187. 1961.

The effect of farmyard manure and ammonium sulphate at different levels on wheat has been studied since 1953-54. It includes three levels of farmyard manure, three levels of ammonium sulphate, and five combinations of farmyard manure and ammonium sulphate. An attempt has been made to study the effect of different forms alone, or in combinations, nature of response, and economics. The author concludes that:

1. Nitrogen in farmyard manure has little manurial value. It is necessary to apply a high dose of nitrogen in farmyard manure to get an increase in yield of wheat.
2. Addition of inorganic nitrogen to farmyard manure does not increase the efficiency of either unless the dose of nitrogen in farmyard manure is very high.
3. Response to organic and inorganic nitrogen is linear.
4. Rate of response of ammonium sulphate is significantly higher than

either farmyard manure alone or in combination.
5. Nitrogen in ammonium sulphate is three times more efficient than nitrogen in farmyard manure.
6. Application of farmyard manure alone is not economical.
7. For short-term effect, one should use only ammonium sulphate and for long-term effect a combination of ammonium sulphate and farmyard manure at the rate of 120 lb. N per acre in farmyard manure and 40 lb. N per acre as ammonium sulphate is recommended.

Indian Agr. Res. Inst., New Delhi, India.

Domingo, C. E., and Robins, J. S. NITROGEN UPTAKE AND YIELD OF IRRIGATED SPRING WHEAT AS RELATED TO NITROGEN AND MOISTURE VARIABLES. Proc. Eleventh Annual Fert. Conf. of the Pacific Northwest, Salt Lake City, Utah. July 13-15, 1960. pp 127-139. 1960.

Marked depressions in irrigated spring wheat yield resulted from severe moisture stress whether imposed before, during, or following heading or during the maturing process. Marked grain and vegetative yield responses to nitrogen were obtained in 1957, but high residual nitrogen from a preceding dry bean crop precluded nitrogen response in 1955. At the high level of nitrogen nutrition in 1955, both grain and straw were enriched in nitrogen content and total nitrogen uptake was appreciably increased by nitrogen addition. At a lower level of nitrogen nutrition in 1957, nitrogen content of the grain was unaffected, but nitrogen content of the straw was increased by nitrogen application. Total nitrogen uptake was materially increased by nitrogen application in 1957.

Severe moisture stress at any stage of growth generally increased the percent of nitrogen in both the grain and straw but reduced yields resulted in lower nitrogen uptake. Periodic measurements of total dry matter and nitrogen uptake in 1955 indicated a marked reduction in both dry matter production and in nitrogen uptake when severe moisture stress was imposed. Severe moisture stress prior to heading resulted in marked second growth following an irrigation at heading. Reduced vegetative growth due to stress before heading greatly reduced susceptibility to lodging and stem breakage. Addition of nitrogen greatly increased lodging susceptibility.

From a practical standpoint, maximum economic nitrogen rate for spring wheat production is in the order of 100 to 120 lbs. available N per acre. Where appreciable residual soil nitrogen exists from either leguminous or commercial sources, nitrogen additions can be correspondingly reduced. Moderate moisture stress can be tolerated without measurable yield reduction at any time during the growing season, but stress severe enough to cause appreciable firing of the lower leaves should be avoided. Adequate water should be available during the maturing process or marked yield reductions will result.

SWCRD, ARS, USDA, Mitchell, Nebr.

Martin, W. E. and Mikkelsen, D. S GRAIN FERTILIZATION IN CALIFORNIA. Calif. Agr. Expt. Sta. B. 775, 39 pp. 1960.

The results of a five-year study on grain fertilization was summarized. A total of 221 coordinated field tests was carried out in 38 counties by the Agricultural Extension Service in cooperation with the Department of Agronomy. The study was made during the period 1947 through 1951, on farms selected by the University of California Farm Advisors as typical of the grain-producing areas of their counties.

Results of this program have been released locally in the counties involved and have formed the basis for fertilizer recommendations for those areas and a starting point for additional local fertilizer tests. The purpose of this report is: (1) To present results of the entire program of field fertilizer tests; (2) to show the fertility status of grainlands in various regions throughout the state; and (3) to indicate what fertilizers may most effectively be used on grainlands under the varying systems of culture and climatic conditions of the state.

Calif. Agr. Expt. Sta. Ext. Serv., Davis, Calif.

Harper, H. J. EXPERIMENTS ON FERTILIZATION OF COTTON, ALONE AND IN ROTATIONS AND WITH GREEN MANURE CROPS, ON THREE CENTRAL OKLAHOMA SOILS, 1927-1958. Okla. State U. B. B-569, 27 pp. 1960.

Experiments involving the fertilization of cotton were conducted for periods ranging from 15 to 30 years at three locations in central Oklahoma. The periods of time covered by these experiments were such that the average annual data reported represented most of the climatic extremes likely to be encountered in central Oklahoma.

The soils on which the experiments were conducted were Kirkland sil at Stillwater, Norge l near Perkins, and Durant l near Lone Grove. These soils are all low in available mineral phosphate, but contain enough organic matter and exchangeable potassium to produce high cotton yields when rainfall is favorable.

Response to phosphate fertilization was least on the Kirkland soil at Stillwater. However, superphosphate produced a statistically significant increase in the yield of cotton grown in a three-year rotation with summer legumes. At Perkins, 40 lbs. of P_2O_5 per acre gave statistically significant increases. At Lone Grove, seed cotton production increased rapidly with increasing rates of phosphate fertilization up to 32 lbs. of P_2O_5 per acre.

Potash did not significantly increase cotton yields at either Stillwater or Perkins. At Lone Grove, increasing the percentage of potash in the fertilizer delayed fruiting and caused a decrease in cotton yields.

Summer legumes grown every third year at Stillwater increased the yields of cotton the other two years, but not enough to warrant use of this system except when cotton acreage is restricted.

Cotton production was nearly as high where it was planted every year and fertilized moderately as it was when grown every eighth year in an alfalfa rotation.

Winter cover crops plowed under as a green manure reduced cotton yields on both fertilized and unfertilized plots at both Stillwater and Lone Grove.

Average annual labor income was computed on the basis of data obtained in some of the experiments, using a yield of 480 lbs. of seed cotton per acre as the break-even point. The results indicate the hazard involved in applying high rates of fertilizer to cotton in this area unless irrigation water is available to supplement summer rainfall.

Agr. Expt. Sta., Okla. State U., Stillwater, Okla.

Entomology Research Division. THE COTTON FLEAHOPPER: HOW TO CONTROL IT. U. S. Dept. Agr. L. 475, 8 pp. 1960.

The cotton fleahopper is an insect that feeds on the juices of buds, tiny squares, and other tender parts of the cotton plant. This pest may reduce yield, and in a severe, persistent infestation can destroy a crop.

The cotton fleahopper occurs in all the major cotton-producing States.

Applying an insecticide is the only practical means of controlling the cotton fleahopper. It is not practical to destroy weeds on which it feeds and develops.

Recommended dusts and sprays are given for the control of fleahopper as they occur alone and as they occur in fields with other undesirable insects.

ARS, USDA, Inform. Div., Washington 25, D. C.

Taylor, W. E. THE EFFECTS OF SEED COTTON TRAMPING ON LINT GRADES AND VALUES. Okla. State U. B. 570, 14 pp. 1960.

Recommendations concerning the production of high grade cotton usually advise against tramping or even walking on the harvested cotton as it is deposited in the wagon. This recommendation seems logical, as tramping might be expected to grind some of the fine trash and leaves further into the lint, thereby making them more difficult to remove at the gin.

From three years of study using three varieties of cotton and two methods of harvest, there is little indication that the Oklahoma cotton producer would suffer a loss of grade or returns as a result of tramping hand-snapped or machine-stripped cotton in the wagon as it is harvested, in order to reduce the amount of wagon space required.

AERD, ARS, USDA, and Okla. Agr. Expt. Sta., Okla. State U., Stillwater, Okla.

Woodruff, C. M., McIntosh, J. L., Mikulcik, J. D., and Sinha, H. HOW POTASSIUM CAUSED BORON DEFICIENCY IN SOYBEANS. Better Crops With Plant Food 44(4): 4-8, 11. 1960.

In a study of boron deficiency in soybeans caused by addition of potassium fertilizers the authors made the following conclusions.

1. The reason for depression of growth of soybeans by large amounts of potassium on a low boron soil is complex. It is related in part to a depression of the uptake of boron by the plant and also, the subsequent depression of the uptake of calcium and magnesium. With adequate amounts of boron in the soil, large amounts of potassium produced no such adverse effects.
2. The tendency of potassium to depress the concentrations of calcium and of magnesium in plants, sometimes leading to symptoms of deficiencies of these elements, may in many cases indicate only that the soils in question lack sufficient boron.
3. It would appear that where soils are low in boron, the evaluation of the effects of potash fertilizer by field plot tests should be made only in conjunction with applications of boron--or after ascertaining by means of soil tests that adequate amounts of boron are present.
4. If the results of soil tests are to provide reliable guides for the fertilization of soils, especially in regions where soils may need boron, then soil testing laboratories should be equipped to make a test for boron. A knowledge of the potassium-boron relationship should aid in establishing suitable standards for such tests.

Mo. Agr. Expt. Sta., Col. Agr., U. Mo., Columbia, Mo.

Miller, G. W., Brown, J. C., and Holmes, R. S. CHLOROSIS IN SOYBEAN AS RELATED TO IRON, PHOSPHORUS, BICARBONATE, AND CYTOCHROME OXIDASE ACTIVITY. Plant Physiology 35: 619-625. 1960.

PI-54619-5-1 (PI) and Hawkeye (HA) soybeans were grown using split-medium and split-root techniques to separate iron from the precipitating effects of bicarbonate and phosphorus. For comparative purposes, these were grown in complete solution cultures where iron, bicarbonate, and phosphorus were in direct contact with each other.

PI and HA soybeans did not develop chlorosis when grown using split-medium or split-root techniques with roots in 10 meq/l $NaHCO_3$ at comparatively low phosphorus concentration. In comparison, PI soybeans developed chlorosis in complete solution cultures when 2 meq/l $NaHCO_3$ was in solution. Cytochrome oxidase activity decreased with increasing bicarbonate concentration in complete solution cultures, but was dependent upon phosphorus concentration in the split-root experiments.

Bicarbonate in solution cultures increased the soluble phosphorus concentration in solution. Development of iron chlorosis was more related to phosphorus concentration in solution or that absorbed by the plant than by bicarbonate concentration in solution. Cytochrome oxidase activity was affected by the phosphorus concentration.

Bicarbonate does not appear to be a direct cause of iron chlorosis or directly inactivate cytochrome oxidase. An effect of phosphorus concentration on cytochrome oxidase activity was observed.

SWCRD, ARS, USDA, Beltsville, Md.

Gardner, E. P., and Wiggans, S. C. EFFECT OF CLIPPING AND NITROGEN FERTILIZATION ON FORAGE AND GRAIN YIELDS OF SPRING OATS. Agron. J. 52: 566-568. 1960.

Two oat varieties, Clintland and Mo. O-205, planted at Ames, Iowa, in 1956-58 were fertilized at two rates of nitrogen and clipped at varying growth stages to determine the effect of these treatments on forage and grain yields. The following results were obtained: (1) Average forage yields from a single clipping at the 4-, 5-, and 7-leaf stage were, respectively, 100, 350, and 2600 lbs. of dry forage per acre. Additional clippings increased forage yield over a single clipping at the 4- or 5-leaf stage. (2) A single clipping at the 4-, 5-, or 7-leaf stage reduced grain yield by 9, 28, or 98%, respectively. Yields were reduced by 40% and 100% with 2 and 4 additional clippings, respectively, following an initial clipping at the 4-leaf stage. (3) Clipping at any stage reduced lodging. (4) Repeated clippings sharply decreased test weight, whereas single clipping at the 4- or 5-leaf stage had no effect on test weight. And (5) clipping effects were closely related to position and development of shoot apices. Clipping after the 5-leaf stage removed the floral primordia directly, whereas clipping on or before this stage retarded growth and development of the floral primordia but did not remove them.

Iowa State U., Ames, Iowa.

Pfeifer, R. P., and Kline, J. P. A MAJOR CAUSE OF WINTERKILL OF WINTER OATS. Agron. J. 52: 621-623. 1960.

The lack of winterhardiness in winter oats is the principal factor limiting the production of this crop in climates with cold winters. Where winter oats can be produced, they often yield twice as much as spring oats. The yield advantage of winter oats could be realized in cool climates north of their present adaptation region provided that new varieties were bred with increased winterhardiness.

At University Park, Pennsylvania, an attempt was made to determine the usual cause of winterkill in oats. The problem was approached by determining the time winterkill occurred and finding the environmental conditions that were directly associated with winterkill.

During two winters, most of the winterkill in winter oats at University Park, Pennsylvania, occurred in the month of January. The time of death of winter oat plants was associated with the temperature of the soil at 1-inch depth. When the soil was as cold as 22° F., partial winterkilling occurred. When the soil temperature became 11° F., all oat varieties were winterkilled.

Coldhardiness was developed during fall growth in field plantings. Limited growth caused by late planting predisposed seedlings to cold kill.

As age of seedlings grown in the greenhouse increased, differences among hardy and wintertender varieties were demonstrated by a cold test.

In the cold test the percent of surviving oat plants was closely related to the temperature of the soil in which the plants were growing.

Pa. Agr. Expt. Sta., University Park, Pa.

Klebesadel, L. J., and Smith, D. EFFECTS OF HARVESTING AN OAT COMPANION CROP AT FOUR STAGES OF MATURITY ON THE YIELD OF OATS, ON LIGHT NEAR THE SOIL SURFACE, ON SOIL MOISTURE, AND ON THE ESTABLISHMENT OF ALFALFA. Agron. J. 52: 627-630. 1960.

An oat companion crop was harvested at four stages of development to compare the effects of these treatments on the yields of oats, on the intensity of light near the soil surface, on soil moisture, and on the establishment of alfalfa.

The lowest total yield of dry matter from the oats alone was obtained when the oats and subsequent oat regrowth were harvested each time the crop reached a height of 12 to 16 inches. Progressively higher dry matter yields were obtained when the oats were harvested at the boot stage, at maturity, and at the late milk to early dough stage.

The yield of protein per acre from the oats alone was highest when the oats were harvested at either the late milk to early dough stage or the 12- to 16-inch height stage. The yield of protein was intermediate when the oats were harvested at the boot stage and lowest when the oats were harvested at maturity.

Available soil moisture depletion was greater under treatments where the oat companion crop was allowed to develop to more mature stages than where the oats were harvested earlier.

Light effective in photosynthesis that reached the alfalfa seeding was never of low intensity where theoats were harvested each time the leaves reached a height of 12 to 16 inches. Low light intensity prevailed under the oats for only a brief period where the oats were harvested at the boot stage. The alfalfa was under heavy competition for light for a longer period where the oats were harvested at the late milk to early dough stage and especially where the oats were harvested at maturity.

Although harvesting the oat companion crop at maturity resulted in a tendency toward thinner alfalfa stands than where the oats were harvested at immature stages, the stands were adequate to produce yields of alfalfa the following spring comparable with the other treatments having slightly higher alfalfa plant populations.

Wisc. Agr. Expt. Sta., Madison, Wis.

Robinson, R. G. OAT-PEA OR OAT-VETCH MIXTURES FOR FORAGE OR SEED. Agron. J. 52: 546-549. 1960.

Oat-pea mixtures for forage and seed production were compared with each other and with oats-vetch, oats alone, oats + nitrogen, and peas alone at three locations in southern Minnesota.

On a sandy soil in eastern Minnesota, oat-legume mixtures were superior to oats alone in forage yield and protein content; oats-peas were superior to oats-vetch or oats alone in total seed and protein yields per acre.

At the two locations on heavier soil, the advantage of oat-legume mixtures over oats alone for forage was shown in higher protein yield per acre. Forage yields were about the same or slightly less than those of oats alone. Seed yields were somewhat less than those of oats alone but this was more than offset by the higher feed quality of the oat-pea mixtures.

Forty-eight lbs. oats + 90 lbs. peas was a good mixture, but was not clearly superior to several other oat-pea mixtures.

Oats + nitrogen in 1957 trials produced more forage than did oats-peas. Oats-peas produced a higher protein forage and more protein per acre than did oats + nitrogen at two locations. Oats + nitrogen produced more seed per acre than did oats-peas but the latter mixture produced more protein per acre than did oats + nitrogen.

Comparisons of initial stands obtained and viable seeds sown showed a lower percentage established for species in mixture than when alone.

U. Minn., St. Paul, Minn.

Haddock, J. L. SOIL AND WATER MANAGEMENT IN IRRIGATED SUGAR BEET FIELDS. U. S. Dept. Agr. Farm. B. 2149, 11 pp. 1960.

Growing sugar beets on irrigated land is profitable only if yields are high--and high yields are impossible without good soil- and water-management practices. To obtain high yields do these things: (1) Adopt a crop rotation that gives full value from the soil resources. (2) Improve soil structure. (3) Make sure that soil is properly prepared for planting. (4) Plant as early in the spring as possible. (5) Cultivate and thin properly to give the sugar beets a chance to grow. (6) Prepare for early irrigation. Irrigate generously but judiciously. (7) Don't overlook the possibility that the fields may become saline. And (8) supply adequate chemical nitrogen. Supply phosphorus when soil analysis indicates that it is needed.

The main reasons for crop rotation in sugar beet production are: (1) To increase active organic matter in the soil; (2) to make more efficient use of available plant nutrients in the soil; and (3) to aid in control of harmful weeds, insects, and nematodes.

Farmers in the irrigated sugar beet acreas select their rotations from a variety of crops. Alfalfa for hay is usually grown for 3 or 4 years. Sweet corn or potatoes, sugar beets, and small grain or canning peas follow the alfalfa in the order given. Tomatoes, cotton, or melons are worked into the rotation in some parts of California.

Sweet corn or potatoes do well following alfalfa. Cultivation of either of these crops helps prepare the soil for the seeding of sugar beets. Alfalfa for the next cycle in the rotation can be seeded when the small grain or canning peas are seeded.

ARS, USDA, Inform. Div., Washington 25, D. C.

Yoshida, S., Ohnishi, Y., and Kitagishi, K. ROLE OF SILICON IN RICE NUTRITION. Soil and Plant Food 5(3): 127-133. 1959.

The results of silicon-free culture with rice plant were reported in special reference to the occurrence of Akiochi. Some characteristic features were described with the rice plant grown in the absence of silicon. In respect to dry matter production, silicon seems to have little effect at least during the vegetative growth stage, but is necessary to better growth during the reproductive growth stage and better grain yield. The growth of rice plant deficient in silicon became suddenly poor after heading just like Akiochi observed in fields.

Higher content of mineral constituents except silicon in aerial parts was found in minus-Si plant than in plus-Si plant. The accumulation was most remarkable in the case of manganese. It was suggested from fractionation of calcium in leaf-blade that calcium might partly replace silicon in silicon-deficient plant. The accumulation of mineral constituents was considered to be related to excessive transpiration of silicon-deficient plant.

The rice plant deficient in silicon has two remarkable disadvantages, namely enhancement of susceptibility to diseases or insects and excessive consumption of water. These unfavorable effects seem to join together in accelerating poor growth called Akiochi.

Natl. Inst. Agr. Sci., Tokyo, Japan.

Zimmerman, L. H., Miller, M. D., and Knowles, P. F. CASTORBEANS IN CALIFORNIA. Calif. Agr. Expt. Sta. Ext. Serv. C. 468, 12 pp. 1958.

Wide uses of castorbean oil in new manufacturing processes, along with new varieties and harvesting equipment, are making this crop a possible prospect for the farmer, particularly for diverted acres in California. The oil is used in plastics, synthetic clothing and commercial fabrics, nylon bristles, synthetic lubricants, all-purpose greases, hydraulic fluids, artificial leather, pharmaceuticals, soap, printing ink, special low-temperature lubricants and flexible coatings, and fast-drying oils for paints and varnishes.

Plant breeders have reshaped the castorbean plant for machine production and used hybrid vigor to boost yields. Engineers have just developed machines for harvesting the crop.

The U.S. is producing, as of 1957, less than 10 percent of its present needs. The rest is imported from Brazil, India, Mexico, Italy, and Africa. To meet current needs in this country, some 200,000 to 300,000 acres of castorbeans, yielding 1,000 lbs. of beans per acre, would have to be planted (California's average yield was 2,000 lbs. per acre in 1957). The nationwide acreage in 1957 was 15,000 acres, mostly under irrigation, in California, Arizona, and the High Plains area of Texas and New Mexico.

Production costs in California are about the same as for cotton. However, castorbean production is still in a developmental stage as compared with other established field crops.

Castorbeans are well adapted to the Central Valley area in California, especially to the cotton belt. California, Arizona, and Texas may develop into the nation's important production areas. Processing firms, which supply seed and contract for the crops, are located on the west and east coasts.

Calif. Agr. Expt. Sta. Ext. Serv., U. Calif., Berkeley, Calif.

Vegetable Crops

Porte, W. S. NATIONWIDE POLL OF POPULAR TOMATO VARIETIES. Amer. Veg. Grower 8(4): 12-13. 1960.

USDA receives frequent requests for information regarding the tomato varieties currently used in different sections of the country. The variety situation is never static and in recent years shifts in the use of varieties have become increasingly more frequent. This is due in large measure to the extensive tomato breeding programs now maintained by federal and state institutions and by private companies. New productive varieties possessing more resistance to diseases and to fruit cracking gradually replace the older established varieties in many localities.

In order to obtain a more authentic and up-to-date picture of the tomato variety situation, USDA asked the horticultural department of each state to furnish the following information on tomato plantings for that state: (1) The principal processing tomato varieties in order of their importance; (2) the principal fresh market tomato varieties in order of importance; and (3) new commercial tomato varieties that look promising in order of importance.

The geographic distribution of the principal varieties, and the preferences for them within states is given. However, an estimate of the relative acreage and production of the several varieties on a national basis is not presented.

A few varieties seem to dominate the processing industry of the whole country. The Pearson lines with the new Pearson VF tomatoes that possess high resistance to both fusarium and verticillium wilts are the principal processing tomatoes of the far Western States.

In the Central States, Urbana and Garden State are prominent processing varieties. Rutgers is still much used in most of the Eastern States with the new Campbell 146, resistant to fusarium wilt and to fruit cracking, making a strong bid for a large share of this acreage. Rutgers is still listed as one of the principal processing varieties in 18 of the states, and Garden State and Campbell 146, are each named by nine states.

In the fresh market tomato industry, the following varieties are most frequently mentioned as principal varieties used in the respective states: Rutgers, and Moreton Hybrid, 22 states; Valiant, 16 states; Big Boy and Fireball, 12 states; Homestead, 10 states; Stokesdale, 9 states; Glamour, 7 states; Marglobe, Manalucie, Queens, and Sioux, each 6 states; Burpee Hybrid, Earliana and Pearson lines, each 4 states.

In the category of promising new varieties and hybrids the following were named most frequently: Moreton Hybrid, and Glamour, 8 times each; Campbell 146, Big Boy Hybrid, Big Early Hybrid, and Homestead lines, 4 times each.

CRD, ARS, USDA, Beltsville, Md.

Taylor, D. M. MECHANIZED TOMATO HARVEST NEARS. West. Crops & Farm Mangt. 9(10): 17-18. 1960.

The canning tomato industry has scored the latest major victory in the continuing fight against the rising cost of crop production.

The breakthrough came on two fronts: First, agricultural engineers from the University of California cooperated with Blackwelder Manufacturing Company, Rio Vista, in pioneering a mechanical tomato picker.

Alan C. Jensen, secretary-manager of the California Tomato Grower's Assn., predicts the tomato harvest will be 100% mechanized within five years. The mechanical picker will eliminate four out of five workers in the tomato fields.

The second prime requisite, a variety of tomato that lends itself to mechanical picking, is being field tested by its developer, Prof. G. C. Hanna, University of California, Davis. If 1961 plantings are successful, Hanna says the entire industry will be converted to the new strain by 1962.

Cost of the picker will be somewhere in the neighborhood of $15,000. It will pick about 100 tons a day, covering approximately five acres during a 10 hour day, at a speed of about $\frac{1}{4}$ mile per hour.

Cost of labor will run $50 an acre, compared with the present $200 per acre. The average California tomato grower has about 100 acres. The machine will save a grower with 100 acres of vines about $15,000 a year. Thus, the average grower could theoretically amortize the cost of his machine in one season.

How does the machine work? First, a blade cuts the vine at root level. A tiny pick-up conveyor elevates the vine to the separating device. Rubber covered walkers separate the tomatoes from the vines. The vines fall to the ground while the fruit drops onto a de-leafing conveyor.

Next, the de-leafing conveyor carries leaves, trash, and dirt, and deposits them with the vines. Tomatoes roll down the conveyor onto sorting belts, are sorted by hand, then conveyed into bulk bins on a trailer pulled parallel to the harvester. From there, they go to the canners.

A minimum number of workers is needed. One man operates the machine, while four to eight laborers sort. A conveyor operator, two tractor drivers, and a fork lift operator complete the labor roster. These men do the work of 60 hand pickers under the old picking system.

No address given.

Lambeth, V. N. KEEP YOUR TOMATOES COOL. Amer. Vegetable Grower. 8(6): 11, 33, 35. 1960.

Water makes up more than 85% of the composition of the tomato plant and fruit. But more significant in terms of total water usage is the water required to cool the plant by transpiration. The total seasonal needs of 18 to 20 inches must come from stored soil moisture and season rainfall, or from irrigation.

Although the tomato plant can be repeatedly wilted and still survive long periods without rain by reason of its deep roots tapping large soil moisture reserves, it cannot be considered a drought-resistant crop. Experimental data show that when the available moisture supply is depleted below 25% of the soil's field capacity, the tomato suffers.

Water deficiencies can only result in decreased physiological activity, reduced yields, smaller fruit, and lowered quality. Deficiency symptoms range from slowed growth and wilting of foliage to dropping of buds and flowers and severe blossom-end rot of the fruit where the deficiency coincides with heavy fruit set and reduced uptake of calcium. These symptoms are distress responses of the plant and they occur too late to serve as an effective guide for timing irrigations.

During the prolonged drought in Missouri in 1953, large differences in daily water use occurred depending largely on the stage of crop development, intensity and duration of sunshine, and level of moisture stress.

In early June with small but actively-growing plants and average day temperatures near 80°F., approximately 1/10 inch of water was used daily. Water usage increased with larger vine growth, rapid fruit development, and in irrigated plots. During the period July 17 to August 5 with maximum day temperatures near 100°F. and with fruit-loaded vines, the water needs increased to 1/3 inch per day.

Even with a full soil reservoir at transplanting time and normal precipitation in June, the available soil moisture will usually be depleted below 25 to 40% range before July 15.

In Missouri, this coincides with the lowest rainfall frequency and the highest daily demands by the crop. This helps to explain why two or three moderate to heavy irrigations, properly timed before depletion of the soil reserves, may make the difference between economic loss and a profitable crop of quality fruit.

Losses of fruit from harvest cracks and subsequent fruit rots may increase with heavy irrigations near harvest. It would appear advisable to refill the soil reservoir at least a week ahead of any heavy flush of bloom and 10 days to two weeks ahead of heavy harvests.

On lighter soils and with varieties responding to extra nitrogen feeding, irrigation may provide the ideal way to time the uptake of nitrogen after the onset of fruiting to continue growth, increase fruit size and yield, and prolong harvest.

U. Mo., Columbia, Mo.

Kallio, A. EFFECT OF FERTILITY LEVEL ON THE INCIDENCE OF HOLLOW HEART. Potato J. 37: 338-343. 1960.

A study was undertaken in 1958-59 to determine if the incidence of hollow heart can be influenced in a susceptible variety of potatoes by varying the levels of N-P-K.

Incidence of hollow heart varied between years. Varying the applications of N-P-K was more effective in increasing the incidence of hollow heart in 1959 than in 1958.

Increasing the nitrogen applications tended to increase the incidence of hollow heart in both years but was more effective in 1959 than in 1958.

Increasing the potassium applications in 1959 tended to reduce the incidence of hollow heart.

Hollow heart was not influenced by the phosphorus applications used in this study.

U. Alaska, Agr. Expt. Sta., Palmer, Alaska.

Costs and Returns

Davis, V. W. IRRIGATION IN ILLINOIS, 1954 TO 1958. U. S. Dept. Agr., Agr. Res. Serv. AERR-33, 26 pp. 1960.

In the spring of 1959, questionnaires on 1957 and 1958 irrigation practices were mailed to a selected group of 240 irrigators, and 145 usable questionnaires were returned. The two questionnaires are the basis for most of the information in this report. Crop seasons of 1957 and 1958 were characterized by adequate to excessive rainfall in most areas of Illinois.

Corn represents about three-fourths of the total acreage of field crops irrigated. Other field crops include soybeans, hay and pasture, and a few acres of wheat, rye, barley, and oats. The specialty crops were gladiolus, vegetable crops, nursery crops, strawberries, and orchard fruit.

Forty irrigators of field crops in Illinois reported average investments of $7,433 per farm, or $86 per acre based on 86 acres irrigated per farm. The average investment of $86 per acre includes distribution system, $51; power unit and pump, $23; and water source, $12. Pipe, fittings, and sprinklers were the chief items of capital investment on nearly all farms. The average investment per farm in the distribution equipment was $4,406. Power units and pumps represent about a fourth of the total investment in irrigation equipment. Twenty-one irrigators used farm tractors, while 19 bought industrial-type stationary engines. The average investment in power unit and pumps was $1,976 per farm. Water supplies from natural streams, lakes, and drainage ditches were available on 16 of the 40 farms. Twenty wells drilled on 14 farms ranged in cost from $475 to $2,900, with an average of $1,219 per well. Ten farmers constructed ponds or reservoirs costing from $540 to $3,500, with an average of $1,754. Cost of developing the water source averaged $1,051 per farm.

Most irrigators of field crops use higher fertilizer application rates and higher plant populations on irrigated than on nonirrigated crops. Fewer than half of the irrigators of specialty crops reported using more fertilizer and thicker planting for irrigated crops.

In 1957, 26 farmers irrigating corn averaged 2,600 more stalks per acre and used 43 more lbs. of nitrogen, 26 more lbs. of phosphoric acid, and 38 more lbs. of potash on irrigated than on nonirrigated corn. Corn was irrigated $2\frac{1}{2}$ times at a rate of 2 inches per acre per application, for an increase in yield of 38 bushels per acre over nonirrigated corn. With an investment of $86 per acre and deduction of all extra costs of fertilizer, irrigation, seed harvesting and handling, the 26 irrigators made a profit of $10.98 per acre, or a 13 percent return on their investment. In 1958, only four irrigators gave complete information on their irrigation. Although they increased plant and fertilizer rates, the estimated increase of 21 bushels of corn per acre was not enough to cover all costs. The average net loss was 3 percent on their investments.

ARS, USDA, Inform. Div., Washington 25, D. C.

Jones, T. L., and Miller F. NATURE AND EXTENT OF IRRIGATION IN MISSOURI. U. Mo. Res. B. 745, 67 pp. 1960.

Irrigation has been common in the vegetable-producing areas of Missouri for many years. For field crops irrigation, most of the expansion has come since 1950. The number of irrigators is still small--approximately 800 among 200,000 farmers.

A mail survey was conducted in the fall and spring of 1958 and 1959 to determine the nature and extent of irrigation in the state.

Of the 352 farmers who reported the year in which they obtained irrigation equipment, only 19 started before 1950 (1921-1949). Fifteen of these 19 irrigators were growing specialty crops. Of those who started irrigating after 1950, 51 irrigated specialty crops and 282 irrigated field crops. The greater number of Missouri farmers started irrigating in 1954.

The average age of the 366 irrigators was 47 years. Farms averaged 494 acres, with an average of 338 acres tillable. Sixty-six percent of the irrigators were full owners, 16 percent were part owners, and 18 percent were tenants.

The field crops irrigated were corn, cotton, pasture and hay, grain sorghum, and small grain. Of the specialty crops, vegetables, orchards, nursery stock, flowers, strawberries, and tobacco were irrigated. Corn was the major irrigated crop in terms of the total number of acres irrigated from 1954-1958 followed by pasture and hay crops, cotton, and then vegetable crops.

For the five years from 1954 to 1958, the largest acreage was irrigated in 1956, when water was distributed on 18,591 acres by 244 farmers--an average of 70 acres per farm. Field crops occupied 15,827 acres; specialty crops occupied 2,764 acres.

Water was used on a wide range of soil types. Twenty-eight percent of the farmers irrigated crops on silt loams; 28 percent on sandy loams; and 11 percent on clay and clay loam soils.

Wells, natural streams or rivers, natural lakes or springs, constructed reservoirs, city water, and drainage ditches were sources of water for irrigation.

Water was applied by sprinklers and by surface methods. Seventy-eight percent, or 283 farmers, used portable pipe and sprinklers exclusively. Four different sprinkler systems were reported. Water from portable gated pipe or ditches to furrows were the two methods of surface irrigation.

Sixty-five percent of the irrigators used internal combustion engines other than farm tractors for pumping water. Twenty percent used farm tractors; 7 percent used electric motors; and 6 percent used a combination of the three methods. Two percent used city water which did not require pumping.

The investment in irrigation equipment in 1954 ranged from $1,596 per farm to $10,871. The average cost per acre irrigated ranged from $351 per acre for the first group to $41 for the second group. The difference in cost per acre was due to number of acres irrigated and to size and type of irrigation equipment.

Ninety-two percent of the farmers were satisfied in various degrees with their past experience with irrigation. The degree of satisfaction was related to the type of crop irrigated. None of the specialty crop irrigators was dissatisfied.

The 29 farmers who were dissatisfied with irrigation gave the following reasons for their opinions: (1) Irrigation required too much labor, and it was difficult to hire workers to move pipe in tall crops; (2) extra yield did not cover the operating costs; (3) at times, rain immediately after irrigation harmed the crops on poorly drained soils; (4) irrigation conflicted with other farm work; (5) the present irrigation system does not distribute the water fast enough; and (6) some of the farmers who had graded or "leveled" their land for surface irrigation reported a decrease in crop yields.

Forty-four percent of the farmers expected to increase the number of acres irrigated within the next five years. Soybeans and grain sorghum were the only major crops for which 50 percent or more of the farmers who had irrigated within the last five years would increase the acreage irrigated.

Thirty farmers had stopped irrigating. Ten had sold their farms and retired; three had insufficient water; one had ground that was too rough for surface irrigation; and 16 said irrigation involved too much labor and extra costs that were not covered by increased returns.

The total number of acres irrigated in Missouri has declined each year since 1956. It is expected that the irrigated acreage will vary over a period of years in the humid area, depending upon the amount of rainfall. Several farmers stated that they had purchased their irrigation system as insurance against total crop failure.

FERD, ARS, USDA, and U. Mo., Agr. Expt. Sta., Columbia, Mo.

Gerlow, A. R. and Mullins, T. ECONOMICS OF SUPPLEMENTARY IRRIGATION OF SOYBEANS. Ark. Agr. Expt. Sta. B. 634, 34 pp. 1960.

Soybeans have become a leading crop in the rice-producing areas of Arkansas; they now contribute about 40 percent of the gross income on rice farms. Supplemental irrigation has contributed prominently to this development.

The opportunities for improving income through supplemental irrigation of soybeans in the Grand Prairie area of central Arkansas and the rice-producing counties of northeastern Arkansas was studied. On farms included in the study, the acreage of soybeans increased from about 20 percent of the cropland in 1955 to about 50 percent in 1959. During years in which droughts were appreciable, about 75 percent of the soybeans were irrigated. Some fields received as many as three irrigations.

The need for supplemental irrigation is determined largely by the amount of rainfall occurring in August and September. An analysis of weather records for a period of 67 years indicates that for about 60 percent of the growing seasons, the amount of rainfall during the "fruiting period" is not adequate for production of optimum yields of soybeans.

Irrigated fields of the cooperating farmers in the Grand Prairie area produced an average of 33 bushels per acre during the five-year period, 1955-59, compared with 25 bushels per acre on the non-irrigated fields. In 1955 and 1956, which were the drier years of the period, irrigated fields produced 15 bushels per acre more than the non-irrigated fields.

For the Northeastern area, the yields of irrigated fields on the survey farms were higher than for non-irrigated fields by an average of 9 bushels per acre during the five years 1955-59.

Practically all wells on the rice farms studied were used to irrigate soybeans and other secondary crops during one or more years of the 1955-59 period. During the drier seasons of this period, about 25 percent of the well operating time was devoted to crops other than rice. The cost of applying water varies with the output of the well and the size of the motor that supplies the power for pumping. For an average 800-gallon-per-minute well operated with a 40 horsepower electric motor, the cost of electricity per application average about $1.25 per acre. For wells that discharged 1,100 gallons per minute and were operated with 40 horsepower motors, the cost of electricity per application averaged $1.00 per acre.

The total cash cost of making an average of 2.3 applications of water, including the cost of building levees and spreading the water, averaged about $5.00 per acre for the Grand Prairie area and $4.00 per acre for the Northeastern Arkansas area. Addition of a prorata share of the overhead cost of the well gives a total cost (cash and non-cash) for irrigating soybeans of $6.42 per acre for the Grand Prairie area and $5.22 per acre for the Northeastern area.

During "dry years", the estimated returns to land and management averaged $33 per acre for irrigated soybeans in the Grand Prairie area, compared with $16 per acre for non-irrigated soybeans. When both "dry" and "wet" years were included in computing the average returns for the five-year period, the estimated returns to land and management averaged $39 for irrigated fields and $31 for non-irrigated fields.

During "dry years" for the Northeastern area, returns to land and management averaged $28 per acre for irrigated soybeans and only $11 per acre for non-irrigated soybeans. For the five seasons including both "dry" and "wet" years, the difference averaged about $12 per acre in favor of the irrigated fields.

On a farm with a limited supply of water for irrigation, the operator may find it necessary to reduce either the acreage of rice grown so he can irrigate soybeans, or the acreage of irrigated soybeans if he decides to produce the same acreage of rice. The effect on the operator's income of substituting irrigated soybeans for rice will depend largely upon the relative yields per acre and the prices received for the two crops.

Based on 1959 prices received for rice, the estimated returns to land and management on farms in the Grand Prairie area would be reduced about $87 for each acre that is left out of rice. Substitution of irrigated soybeans on this acre and use of the water that would then be available to irrigate 1.64 acres of dryland soybeans would add only $52 in returns to land and management. Hence, at 1959 prices, substitution of irrigated soybeans for rice in the Grand Prairie area would result in a loss of $36 per acre.

In the Northeastern area, substitution of irrigated soybeans for an acre of rice would reduce the returns to land and management by about $27.

With soybeans selling at $2.00 per bushel, the returns on farms in the Grand Prairie area from rice and irrigated soybeans would be about equal when rice sells at $1.60 per bushel. On farms in the Northeastern area, the returns would be about equal when rice sells at $1.75 per bushel.

FERD, ARS, USDA, and Agr. Expt. Sta., U. Ark., Fayetteville, Ark.

Hughes, W. F., and Magee, A. C. SOME ECONOMIC EFFECTS OF ADJUSTING TO A CHANGING WATER SUPPLY, TEXAS HIGH PLAINS. Tex. Agr. Expt. Sta. B. 966, 27 pp. 1960.

Regional static water levels declined about 43 feet during the 22-year period, 1937-58. This is an average for the groundwater reservoir as a whole. It ranges from a few feet to around 100 feet in different parts of the reservoir. The effects of this decline and the number, types, and extent of adjustments vary considerably, depending on major soil type, initial (1938) thickness of the water-bearing stratum, the permeability of water-bearing materials, and the proportional amount of depletion experienced in specific hydrologic situations.

The principal short-run physical effects of a decline in water levels are reflected by a reduction in well capacities. The long-run effect is a depleted water supply. The types of special practices or adjustments induced by or associated with the decline in water supplies include: (1) Increasing the number of hours of pump operation; (2) lowering pumps; (3) installing additional wells; (4) installing closed water-distribution systems; (5) installing smaller pumps in old wells; (6) decreasing the acreage of summer-irrigated crops and increasing the acreage of crops irrigated in fall and winter; (7) staggering grain sorghum planting dates; (8) concentrating the available water supply on cotton; (9) irrigating alternate rows; and (10) reducing the number of acres of cropland irrigated per farm.

Physical patterns of ground water depletion are clearly defined. The number, types, and extent of adjustments also are related closely to physical conditions and to the degree of depletion in specific hydrologic situations. The economic patterns stemming from these adjustments are not so clearly defined.

Several factors combine to obscure the full physical and economic effects of water level decline. Among these are: continuation, though at a slower rate, of irrigation development; elimination or reduction of transmission losses through the use of a closed distribution system; inflation; drouth and a modified irrigation program; and the shift from butane to natural gas for pumping fuel.

Elimination or reduction of transmission losses particularly has had a masking effect. In some situations, the quantity of water saved by piping water to the place of use may have been substantial. Thus, although the yield of a well may have deteriorated badly, the acreage served by the well may be near that served before the conduits were installed.

Closed distribution systems, principally underground concrete tile, served approximately 40 percent of the land irrigated in 1958. Approximately 80 percent of the systems used in 1958 were installed during 1954-58. The proportion of farms equipped with these systems ranges from 16 percent in lightly depleted areas to 100 percent in some of those more severely depleted. As the full effect of past water level declines have been offset to some extent by the elimination or reduction of transmission losses, future declines are likely to result in a greater reduction in irrigated acreage and a greater increase in costs than those that occurred during 1954-58.

The effects of adjusting to declining water supplies are reflected in increased per-acre investment in irrigation facilities, increased operating costs per acre, and a reduction in the acreage of cropland irrigated per farm.

Agr. and Mech. Col. Tex., Tex. Agr. Expt. Sta., College Station, Tex.

Ellis, H. M. GETTING DOWN TO DOLLARS AND CENTS. Irrig. Engin. and Maintenance 10 (11): 7. 1960.

Sound financing has been cited as a key factor in the adoption of a new practice which has added $660,000 to the annual agricultural income of Rockingham County, North Carolina.

Rockingham County's success story began in 1952 when dry weather seriously hurt the county's principal crop, tobacco.

The success of farmers who had irrigation systems convinced a lot of sound business people that irrigation could solve many of their dry weather problems, particularly in reference to tobacco production.

An agreement was reached. Loans would be made at 25 percent down with three crop years to pay. Dealers were required to endorse their paper at the bank, which made them directly responsible for the design of systems sold and for the equipment's proper operation. Dealers had some other responsibilities too. They had to be sure a farmer was ready to adopt irrigation and also make certain that he had the information and equipment to do the job properly.

Today there are 400 irrigation systems in the county, costing an average of $2,000 each. Banks loaned $400,000 of the money required to buy the systems.

The county has 12,000 acres of tobacco. Today one-third of the acreage is irrigated as compared with an overall State average of only 12 percent. In addition, 500 acres of other crops are irrigated with the systems.

In 1959 tobacco farmers who irrigated averaged $250 per acre more gross income than farmers who didn't. Irrigation expenses per acre were about $85, leaving an additional net income of $165. The average tobacco farmer who irrigated averaged $1,100 more for his crop than the farmer who didn't.

During the past seven years, tobacco yields in Rockingham County have increased between 450 to 500 pounds per acre, and the quality of the crop has greatly improved.

Agr. Engin. Ext., N. C. State Col., Raleigh, N. C.

Bissell, L. P. FARM WOODLOTS COSTS AND INCOME. Maine Ext. Serv. C. 338, 12 pp. 1960.

Records of the first five years of woodlot management on the Penobscot Experimental Forest demonstrated that productivity of the small woodlot can be increased by use of simple management methods.

Specifically: (1) Improvement cuttings may be made in mixed stands annually at a profitable rate of return per hour and per acre; (2) returns per man hour on piecework (cutting by the cord or by the thousand board feet) were more than double the returns per man hour when woods labor was hired by the hour; (3) future logging operations should show higher returns per man hour because improvement cuttings to date have increased the volumes of better species, improved tree quality, and improved access to the woodlands; (4) yields of .5 and .8 cords per acre per year brought in $6.06 and $9.90 per acre per year after paying major cash expenses, a good return to a landowner for his labor and his investment in a woodlot.

Recommendations to woodlot owners: (1) Make improvement cuttings (weeding, thinning, pruning) to improve growth rates, timber species, and timber quality; (2) mark mature timber before selective cutting to remove mature or defective trees, leave healthy trees for another cut, and to provide for natural seeding of desirable forest trees; (3) plant forest trees when natural reproduction is not adequate; and (4) get forestry advice and assistance for the best management of your woodlot.

FS, USDA, AND U. Maine Agr. Ext. Serv. Orono, Maine.

Olson, D. F., Jr., and Doyle, H. J. PIEDMONT FARM WOODLANDS: INCOME FOR LANDOWNER, RAW MATERIAL FOR INDUSTRY. Furniture, Plywood, and Veneer Council, N. C. Forestry Assoc. Rpt. 5, 18 pp. 1959.

Farm forests comprise 88 percent of the forest acreage of the North Carolina Piedmont. The average ownership is only 49 acres, but the 104,000 farm families in the region control 5.1 million acres of forest. Very few of these woodlands are now being managed at anywhere near their peak capacity, and surveys show that the quality of the timber and the cutting practices employed are poor.

To determine the management possibilities of planned farm woodland operations for furniture timbers, foresters of the North Carolina Piedmont Hardwood Forest Research Project set aside two areas (43 and 47 acres) of pine-hardwood forest.

Woodland management objectives are geared for a high level of production of hardwood timber, but do not ignore the income-producing ability of pine. Hardwood management is stressed because the hardwood forests of the Piedmont are increasing, and are located in the middle of the world's largest area of wood furniture producers, where markets for good quality hardwoods abound. Each individual acre of woodland is handled for maximum return in keeping with the primary purpose and is used to grow the kind of timber best suited to the soil and topography. This often means that pine is favored as a crop tree in some places, either by developing existing stands or planting in openings. Also, provision has been made for leaving some trees of persimmon, dogwood, hickory, sourwood, and others of special value for honey production, wildlife, and other uses.

Income, costs, and net profit for the initial management period (1955-1958) are summarized in the table, based on stumpage sale figures.

TABLE.--Income, Costs, and Net Profit From Woodland Operation
(1955-1958)
(In dollars per acre)

Item	Mooresville woodland	Chesterfield woodland
Income		
Sawtimber	15.03	24.00
Pulpwood	3.53	7.91
Wind salvage	0.0	4.85
Total	18.56	36.76
Costs		
Taxes	1.40	1.40
Timber Stand Improvement	4.40	2.40
Planting	0.71	0.13
Roads	0.0	2.36
Total	6.51	6.29
Net profit (incl. pulpwood)	12.05	30.47
Net profit (without pulpwood)	8.52	22.56

The profits reported do not include deductions for the fixed costs of interest and protection. These costs are variable; but since interest, protection, and taxes are fixed costs, they would be the same for well-managed woodlands as for poorly-managed tracts.

Marked improvement can be expected in growth and quality of both woodlands since the management program has begun. Both areas have shown a net return after all expenses were paid, and indicate that an owner can make a sound investment in woods improvement and earn money at the same time.

Southeastern Forest Expt. Sta., FS, USDA, Asheville, N. C.

Clague, T. SHOULD YOU RENT EQUIPMENT? West. Crops & Farm Mangt. 9(12): 25. 1960.

Whether or not the farmer should rent farm equipment obviously depends on whether it will be more profitable to rent than to own the machinery.

The Farm Equipment Retailers' Assn. has recommended a schedule of prices for dealers to use--one day 1% of new delivered price, one week 5%, one month 15%, two months 25%, and three months 33 1/3%.

The key to the matter of renting is whether it is better business to pay rent for a unit during a busy season, or to buy it and lose depreciation and interest. The economics of any given situation should determine the decision.

Economists suggest that annual rentals of up to 20% of the price of new equipment is economical. This would be perhaps six weeks' use for the equipment, according to the schedule. If the equipment is needed for a longer time than this, it is probably better to own it.

Be sure to get all the details worked out before renting. Who picks up the equipment and returns it? Exactly when does the rental period start and end? Who pays for damage and wear? What is "normal wear and tear?" What if it rains and the equipment cannot be used? What does each furnish in the way of supplies?

If the decision is to rent, then it's more important than ever to manage very carefully to make the most of the investment. Have everything ready to go, and planned out, so that every dollar spent gives a good dollar's worth of work done. To rent, plan as far ahead with the dealer as possible.

In addition to letting the farmer "catch up," or try a new practice or crop, renting also offers the opportunity for one to try equipment on a more thorough basis than is possible during a short demonstration.

Whether or not renting is good depends upon the situation, and whether a dealer will rent the equipment.

No address given.

Davis, E. G. THE ECONOMICS OF FARM MECHANIZATION IN THE UNITED STATES, 1950-1960. Library List 68, 16 pp. 1960.

This selective bibliography is concerned with the costs of mechanization on the farm and the returns to the farmer therefrom, either in reduction of labor costs or in the increased value of the crop. It is a representative rather than an exhaustive compilation of the literature since 1950, and includes the first few months of 1960.

The bibliography is arranged in alphabetical order, by primary author, and has a combined index of subjects and secondary authors. The list contains 262 articles.

U.S.D.A. Libr., Washington 25, D. C.

Parsons, M. S., Robinson, F. H., and Strickler, P. E. FARM MACHINERY: USE, DEPRECIATION, AND REPLACEMENT. U. S. Dept. Agr., Agr. Res. Serv. Statis. B. 269, 37pp. 1960.

Farm machines have played a major role in the revolutionary changes that have occurred in United States agriculture in the last two or three decades. In 1959, investment in machines amounted to 10 percent of the value of physical assets on farms, as compared with about 6 percent of a much smaller total value in 1940. Machinery costs make up an increasing share of total farm costs, and efficient use of machinery is becoming more and more important as part of the farm management job.

Farms in the United States are more highly mechanized than ever before, but most machines are used less than they were 10 to 15 years ago. A recent national survey of machinery use shows, that the average grain combine harvests about 120 acres per year. This figure compares with about 250 acres in 1941. Pickup hay balers average around 200 acres as compared with 330 in 1941. These decreases in use are the result of an increase in machine numbers and capacity--an increase that has exceeded the rate of growth in the amount of work to be done with the machines.

Annual use of farm machines varies widely from farm to farm, depending on age and size of machine, type and size of farm, and other factors. Generally speaking, annual use is low relative to potential use, averaging less than 100 acres per year for plows, planters, field forage harvesters, and several other important machines. Heavy use is associated with the newer and larger machines and with the larger farms. For most machines, the average use on farms of 220 acres or more is three to four times the average use on farms of 100 acres or less. Operators of smaller farms tend to do more custom work to spread the ownership costs of expensive machines and to keep per-unit costs at acceptable levels.

Depreciation is a major cost of owning and operating farm machines. The average useful life and the depreciation rate of a particular machine may vary from one period to another. Wheel tractors, for example, have had an average useful life of 17 to 20 years since 1940 as compared with about 12 years in the two or three decades immediately preceding 1940. For most other machines, the generally accepted standards of useful life still seem to be reasonably satisfactory.

The inventory of machinery on farms has reached a high level. Apparently, the saturation level has been reached for some machines and a near-saturation level for others. The future market for farm machines will become more and more a replacement market rather than one that depends on the further building up of machine numbers on farms.

The replacement of farm machines is characterized by a large amount of trading in used machines. Depending on the machine, from a third to half of those now on farms were brought as used machines by current owners. Used machines are more likely to be found on the smaller farms, and new machines on the larger farms.

Tables

ARS, USDA, Inform. Div., Washington 25, D. C.

Bird, R., and Miller, F. PROFITABLE ADJUSTMENTS ON FARMS IN EASTERN OZARKS OF MISSOURI. U. Mo. Res. B. 735, 44pp. 1960.

In 1955, average family net income of all farm households in the Eastern Ozark area was $2,042, of which only $658 came from the farm. Gross farm income did not cover farm operating costs on 28 percent of the farms. If 5 percent interest is allowed on capital, no return to labor and management was earned on 53 percent of the farms.

Several reasons for the low farm income situation were apparent. One relates to the number and type of workers on farms in the area. Forty percent of the farms had fewer than one man-equivalent in the labor force. Many of the operators were limited as to the amount and kind of work they were able to perform because of age, poor health, or other handicaps. Another reason relates to the small size of many farm businesses. Also, many of the able-bodied farmers were engaged in part-time farming. Returns to approximately 42 percent of the part-time farmers did not cover the costs of operating their farm businesses. On most farms, low returns to the farm business were related directly to the choice of enterprises and levels of efficiency of management. Farm operators had diversified their operations to make use of all type of land and to maximize the use of their labor. As a result, they had spread management and use of labor and capital resources among many small enterprises. In many instances this limited financial returns.

Farmers in the Eastern Ozark area could increase net income by greater specialization in the most profitable enterprises. Assuming 1953-57 price relationships and improved production practices, an able-bodied, capable manager, with a medium-sized farm, could have expected net returns to land, labor, and capital from a unit of various enterprises as follows:

1.	Beef cow-feeder calf (per cow)	$ 7.77
2.	Feeder calf, wintered and grazed (per calf)	$ 24.35
3.	Feeder calf, wintered (per calf)	$ 10.55
4.	Yearling, grazed (per yearling, summer only)	$ 13.80
5.	Sheep (per ewe)	$ 10.73
6.	Dairy cow (per cow):	
	Grade A market, 4,000 lbs. of milk per year	$ 46.96
	Grade A market, 8,000 lbs. of milk per year	$ 126.36
	Grade C market, 4,000 lbs. of milk per year	$ -1.03
	Grade C market, 8,000 lbs. of milk per year	$ 24.37
7.	Feeder pigs (per sow and 14 pigs)	$ 115.92
8.	Fattening hogs (14 feeder pigs to sale weight)	$ 87.22
9.	Laying hens:	
	100 hens	$ -16.00
	250 hens	$ 114.00
	500 hens	$ 942.00
	1,000 hens	$1,926.00
10.	Broilers (20,000 birds per year)	$ 793.00
11.	Corn (per year)	$ 32.18
12.	Corn silage (per acre)	$ 28.60
13.	Lespedeza and small grain, double-cropped (per acre)	$ 10.14

Under conditions on most farms, some diversification may be necessary for efficient use of all land or labor available. To evaluate various situations, farms were selected for study which were representative of those in each Economic Class of farms enumerated in a survey made in 1955. The present organization and practices, as well as nine different livestock organizations with improved practices, were budgeted for each typical farm. The net returns to owned land, labor, and capital at 1953-57 prices were as follows:

Economic class of farm	Returns with 1955 organization and practices	Returns with best alternative organization and improved practices	Best alternative organization
Class II	$3,335	$8,086	Feeder pigs and yearling steers grazed
Class III	$3,414	$9,306	Feeder pigs, hogs fattened and yearling steers grazed
Class IV	$1,533	$8,033	Feeder pigs and yearling steers grazed
Class V	$ 754	$7,667	Feeder pigs, hogs fattened and yearling steers grazed
Class VI	$ 293	$5,413	Feeder pigs, hogs fattened and yearling steers grazed
Part-time farm	$ -267	$2,538	Feeder pigs, hogs fattened and yearling steers grazed
Residential farm	$ 100	$3,662	Feeder pigs and hogs fattened

FERD, ARS, USDA, and U. Mo., Agr. Expt. Sta., Columbia, Mo.

Ellis, T. H., and Partenheimer, E.D. COSTS AND RETURNS FROM LIVESTOCK PRODUCTION IN THE LIMESTONE VALLEY AREAS OF ALABAMA. Auburn U., Agr. Expt. Sta. 4 l, iii, 75 tables. Dec. 1960.

Input--output relationships, costs, and returns for major types and sizes of livestock enterprises are presented in table form. Selected supplemental feed budgets are included. Two levels of technology are presented for most of the enterprises. Existing management practices are those production techniques being followed by the "average" livestock producer in the area. Improved practices are the techniques followed by the best producers in the area. Neither the improved nor the existing practices budgets will exactly fit any particular farm.

These livestock and supplemental feed crop budgets are specifically adapted to the Limestone Valley Areas of Alabama and are generally applicable to similar areas in Georgia and Tennessee. They can also be applied to local situations in other immediate areas by making the necessary changes for differences in physical and price-cost relationships. Thus, they form the basis for valuable contributions to production relationships for livestock enterprises in all parts of these several areas.

FERD, ARS, USDA, and Auburn U. Agr. Expt. Sta., Auburn, Ala.

Butler, C. P., and Burch, T. A. PRODUCTION REQUIREMENTS AND ESTIMATED RETURNS FROM SELECTED CROP AND LIVESTOCK ENTERPRISES IN THE PIEDMONT AREA. S. Car. Agr. Expt. Sta. AE 202, 133 pp. 1960.

This computation of production requirements, costs, and returns for selected farm enterprises in the Piedmont can be useful to farmers, credit agencies, and others interested in agriculture, in arriving at intelligent management decisions. It contains data applicable to particular sets of economic and physical conditions, but it does not provide for all production situations. It does suggest a method and a procedure that farmers may use in appraising their production situations which will permit them to make intelligent decisions with respect to the use of the resources they own and to achieve their objectives as to income, conservation, and leisure.

Decisions with respect to choice of enterprises or management of particular enterprises need to be made in light of the combined effects of changing prices and technology. Forces outside the farm boundaries influence these changes. It is, therefore, essential for farmers to observe the behavior of these changes in trying to predict future changes. The accuracy of their predictions may determine the course of action that will lead either to financial success or to failure.

Tables.

FERD, ARS, USDA, and S. C. Agr. Expt. Sta., Clemson Agr. Col., Clemson, S. C.

Fox, A. S. CHANGES IN ORGANIZATION, COSTS, AND RETURNS ON DAIRY-HOG FARMS IN SOUTHEASTERN MINNESOTA 1930-59. U. S. Dept. Agr., Agr. Res. Serv. ARS 43-124, 48 pp. 1960.

In the last 30-year period, dairy-hog farmers in southeastern Minnesota increased the size of their farm organization and adopted improved production practices. Additional costs were overshadowed by the greater additional returns, so that net farm incomes were nearly 7 times higher in 1956-59 than in 1930-33; ($3,944 in 1956-59 and $584 in 1930-33). After World War II, farm incomes leveled off but costs continued to rise. During this 30-year period these farmers experienced the effects of a major depression, a severe drought in the 1930's, World War II in the 1940's, the Korean War in the early 1950's, and a defense-oriented national economy since. The effects of gradual changes are more apparent when viewed over the years, and the influence of weather and other year-to-year changes, are less likely to obscure underlying trends.

From 1930-34 to 1959, the average size of farm increased by about 24 acres and crop yields by more than 70 percent, with most of the increases occurring after 1950. The higher yields were obtained chiefly by using more fertilizer, lime, higher quality seed, and additional kinds of fungicides and insecticides.

Both milk cow numbers and production per cow increased more than 40 percent during the period. Production of pork fluctuated considerably from year to year, but overall, it increased by about a third. In the later years, better management resulted in higher feeding rates and more efficient production of higher quality livestock. The increase in both crop and livestock production resulted in more than a doubling of total farm production between 1930-34 and 1959, with almost half of the increase occurring after 1950.

This greater production was realized by using more total capital and by substituting machines and other goods and services of nonfarm origin for horse and man labor. Although the constant dollar value of machinery remained fairly stable throughout the 1930's, it doubled from the early forties to 1959. Also, farm operations in the latter years were performed with one-forth less man labor than had been used earlier and with a negligible amount of horse labor. In 1959, production per hour of labor was about twice as high as in the early forties, but production per unit of capital was considerably lower.

In general, prices received for products sold increased less than prices paid for goods and services used in production. However, the relatively greater increases in production and the threefold increase in wage rates encouraged the shift toward use of machine labor.

The higher incomes resulting from the combined effect of these changes allowed returns allocated per hour of operator and family labor in increase from almost nothing in 1930-33 to about $0.36 in 1940-44 and $0.56 in 1956-59. These returns compare favorably with those on dairy farms in Wisconsin, but they are generally less favorable than returns on many of the Corn Belt farms to the South.

As these returns pertain to commercial farms whose operators are fully employed, they include earnings from farm operations only.

Tables, charts, and graphs.

ARS, USDA, Inform, Div., Washington 25, D. C.

Cunningham, L. C. COST AND RETURNS IN RAISING DAIRY HEIFERS: NORTH COUNTRY REGION, NEW YORK, 1955-56. Cornell U. B. 956, 20 pp. 1960.

Heifers were raised on 545 out of 556 commercial dairy farms in the North Country region of New York. The 556 farms represent a 15 percent random sample of all commercial dairy farms in the region. The 14 heifers of all ages per farm were sufficient for the needed replacements in the herds, which averaged 27 cows per farm. Costs and returns were reported on the basis of a heifer to the age of 27 months.

Total costs averaged $190 per heifer, of which 62 percent was feed and 14 percent was labor. Unit costs were much higher on some farms than others, but one-third of the farms had costs within the range of $150 to $200 per heifer.

Total returns amounted to $172 per heifer. At the time of first calving, heifers were valued, on the average, at $177 per head, compared with $170 per head for cows bought and with $175 per head for the average inventory price of all cows. Returns varied widely from farm to farm.

Costs of raising heifers exceeded returns by $18 per head, on the average.

The labor used in raising heifers, 35 hours per heifer, earned an average return of 26 cents per hour. The labor return from producing milk on these farms averaged 55 cents per hour. With all other costs including labor fully covered, dairymen realized $11 per ton for the hay fed to heifers.

The value of the heifer calf and the rearing costs amounted to $206 per heifer. Credits for calves and manuer produced gave a net cost per heifer raised of $187.

Both total costs and total returns per heifer went up as milk production per cow increased.

The larger the number of heifers per farm, the more favorable the net returns per heifer. Although total returns per heifer were unrelated to the size of the enterprise, total costs per heifer decreased as the number of heifers per farm increased.

With medium-sized and large herds of cows, the larger the number of heifers raised, the larger the labor income. Part of the increase in income was contributed by higher milk production per cow. Even though raising heifers did not pay as well as producing milk on these farms, the farm business as a whole profited if at least the normal requirements for herd replacements were raised.

Cornell U. Agr. Expt. Sta., N. Y. State Col. Agr., Ithaca, N. Y.

Cunningham, L. C. COSTS AND RETURNS IN PRODUCING MILK: NORTH COUNTRY REGION, NEW YORK, 1955-56. Cornell U. B. 943, 16 pp. 1959.

The average cost of producing 100 pounds of milk in a random sample of 556 farms in the North Country dairy farming region of New York was $4.27. The data covered the 12-month period ended April 30, 1956.

The farms were specialized in milk production. The herds averaged 27 cows in size and 6785 lbs. of milk per cow in production.

A wide variation in costs was found on different farms. Nine percent of the farms had costs of $6 or more per 100 lbs. of milk produced. Costs equal to or in excess of $5 were found on more than one-fourth of the farms. In sharp contrast, 16 percent of the farms had costs of less than $3.50 per 100 lbs. and 36 percent of the farms were under the $4 level.

Labor made up nearly 30 percent of the total cost of producing milk, and was exceeded in importance only by feed which was 46 per cent of the total. Next in importance was the cost of building use at 5 percent of all costs.

The average cost of $4.27 per 100 lbs. on an enterprise basis compares with an average cost of $4.66 on a whole farm basis. This 9 percent disparity in costs by the two methods suggests that (1) the market prices of some individual cost items charged on the enterprise basis were below their actual costs, and (2) the share of total farm labor cost charged to cows was higher on the whole farm basis than on the enterprise basis.

The average cost of $4.27 exceeded the average price received by 35 cents per 100 lbs. of milk. That is, dairymen realized, on the average, not 75 cents per hour of labor as charged in the cost calculation, but 55 cents per hour for all labor used directly in caring for cows. All other costs were fully covered.

As the wide variation in costs on individual farms indicates, some dairymen made much higher returns for their labor than others. About 10 percent of the farms failed to make any returns for labor, and another 39 percent received less than 50 cents per hour. About one-third of the farms made from fifty cents to $1 per hour and another one-fifth received $1 or more per hour.

On the basis of the average cost of $4.27 per 100 lbs. of milk in the North Country region, the estimated 1955-56 cost for the whole state is $4.54. Taking into consideration changes in farm wage rates, feed prices, and other costs in dairy farming, the estimated cost is $4.71 for 1956-57 and $4.85 for 1957-58. By comparison, the state-wide price received for milk during 1957-58 was $4.53.

Unit costs of milk production showed a close inverse relation to labor incomes. The 86 farms out of the whole group of 556 farms with costs of less than $3.50 per 100 lbs. of milk made an average labor income of about $3300. As unit costs increased, incomes declined sharply. With costs of $5, the labor income was practically zero; with costs of $6 or more, large losses resulted.

Milk production per cow and size of herd were both found to be consistently related to unit costs. The higher the milk per cow and the larger the herd, the lower the cost of producing 100 lbs of milk. The unit costs for the year were lower on farms that produced milk the year round than on farms with a high proportion of summer milk production.

The amount of milk sold per man- a measure that reflects all 3 of these factors - had a powerful effect on unit costs. An average cost of $6.25 per 100 lbs. was found on the farms from which less than 50,000 lbs. of milk was sold per man. As the amount of milk per man increased, the cost per unit went down rapidly. Average costs were only about $3.40 on the farms that sold 200,000 lbs. or more per man. Such a large volume of milk was obtained from the combination of moderately large herds and relatively high milk production per cow.

Cornell U. Agr. Expt. Sta., N. Y. State Col. Agr., Ithaca, N. Y.

Animal Husbandry Research Division. FEEDING DAIRY CATTLE. U. S. Dept. Agr. Farm. B. 2153, 32 pp. 1960.

Feeding dairy cattle involves more than providing them with good feed needed to produce milk; feeding must be done at a profit.

To plan feed crops for cattle, think in terms of lbs. of milk per acre, not bushels or tons of feed. Through increased milk output, one feed may bring more profit than another feed.

Because yearly differences in soil and weather can change the yield and quality of the feed raised, the feeding plan should be flexible. The feed supply available each year should be used effectively.

The feeding program should be simple and workable. It should meet the needs of all the animals in the herd and use the least number of different feed mixtures.

Much of the increase can come by using improved practices in pasturing, harvesting, and preserving forage, and by providing adequate forage rations throughout the year.

The cheapest source of nutrients for dairy cows is home-produced forage crops. Of the forage crops, pasture is the cheapest to produce; next in order are preserved forages and grains. On most farms, 75 to 80 percent of the nutrients required by dairy cattle can come from forage.

This farmers bulletin gives: (1) The feeding need of dairy cattle; (2) the class of feed-forages and concentrates; and (3) recommendations for feeding forage and concentrates to dairy cattle in winter and summer.

Tables.

ARS, USDA, Inform. Div., Washington 25, D. C.

Hess, C. V. PROFITABLE ADJUSTMENTS FOR NEW YORK DAIRYMEN. Cornell U. Agr. Expt. Sta. B. 952, 60 pp. 1960.

An economic evaluation of alternative adjustments that dairymen might make on medium-sized dairy-cash-crop farms located on the Honeoye-Lima soils of the Central Plain Region in western New York is presented. The current situation in the region with respect to the usual combinations of crops and livestock, current farm practices, and income variability were appraised. Adjustment problems and resource situations that might influence the farmers' ability to make appropriate changes in their farm organizations and operations were also considered. A farm management survey made in 1954 of 525 commercial farms in the Central Plains provided much of the basis for an appraisal of the current situation. Representative dairy-cash-crop farms of different sizes were chosen for each of the 3 major soil associations of the region.

A medium-sized, representative farm of 155 total acres with 97 acres of crops, 8 acres of seeded (hayland) pasture and 18 acres of permanent pasture was used as a basis of analysis. An 18-cow dairy and a small 200-hen farm flock constituted the livestock program. The representative situation served as a benchmark from which adjustments were evaluated as to their effect on production, resource requirements, investment levels, costs, and returns. All analyses were carried out using projected prices that are considered to represent the long-term price-cost relationships based upon long-term supply and demand under reasonably competitive market conditions. Several of the more promising adjustment alternatives from among the 43 systems evaluated by budgetary analysis are discussed.

The adoption of improved crop and dairy practices within the present farm organization improved labor income considerably more than increasing the size of business by cash-renting additional cropland, purchasing dairy replacements, or buying or renting another farm.

Increasing the size of herd from 18 to 36 cows, without making any changes in production practices, but providing the necessary barn and silo facilities and additional labor, reduced labor income by $400. Doubling the dairy under improved practices increased labor income by about $5300.

A shift to an intensive grain rotation of C-C-O-W-H (corn, corn, oats, wheat, hay) with improved pasture and crop practices in combination with an 18-cow dairy under improved dairy practices resulted in a labor income of $6200. Supplementing this plan with 1500 layers under improved poultry practices and purchased pullets increased labor income by $500. If the dairy is supplemented with 20 litters of hogs under good management, instead of poultry, labor income increased by $800.

Cornell U. Agr. Expt. Sta., N. Y. State Col. Agr., Ithaca, N. Y.

Van Arsdall, R. N., and Davis, V. PRODUCTIVE CAPACITY OF LIVESTOCK LABOR. U. Ill., Col. Agr. FM 15, 6 pp. 1960.

Low production per unit of labor has been one of the key stumbling blocks in the path of livestock farmers in their struggle to attain a suitable income. High production and high net income per unit of labor require an effective combination of efficient, highly productive animals, and the means for handling them in volume. Either inefficient animals or small enterprises will cut income considerably below potential.

Outdated methods, equipment, and buildings restrict many Illinois farmers to handling only one-third to one-fourth the number of livestock that is technically within their reach. Possibilities for increasing productive capacity per man are greatest where materials handling is a substantial cost to the enterprise and where it can be centralized and mechanized.

Records show that the diary husbandry chores for a 16-cow herd are the equivalent of a full workload for the average Illinois farmer who does most of his chores by hand. Using standard dairy equipment and improved work methods, farmers can raise their capacity to 23 cows. Using the same type of equipment and applying highly efficient work methods to his operations, a farmer can handle 31 cows. A good dairyman who makes full use of the equipment and know-how presently available can handle about 65 cows per man equivalent. Some systems staffed by topflight workers have already been organized to handle nearly 100 cows per man. These capacities are based on dairy husbandry work only and do not include production of feed. Similar relationships exist among other livestock enterprises carried on Illinois farms.

Improved work methods increase the productive capacity of farm workers without adding to cost of production. Mechanization always adds to cost when labor is treated as the receiver of all income rather than as an input with a price on it. Increases in average cost per unit (animal) due to mechanization are relatively small, however, and mechanization usually increases the total income per worker if added productive capacity is fully exploited. For example, a table shows that dairy returns above costs decrease only about 10 percent in the change from a manual to a fully mechanized system--$123.25 to $112.75 per cow. At the same time, the productive capacity of labor is increased fourfold, causing the income over costs produced by a one-man equivalent to increase from $1,972 to $7,329.

Labor-saving methods, equipment, and structures are necessary if large increases in labor productivity are to be expected.

Labor-saving devices cannot help to increase income unless money is also available to buy the livestock, feed, supplies, and other production items needed for enlarging the farm business. Data show that capital needs for such purposes may go as high as $200,000 for a highly mechanized beef-feeding operation large enough to use the time of a one-man equivalent.

Data also illustrate that the degree of mechanization has relatively little effect on total capital requirements. These economies in equipment capital per unit of livestock cannot be realized unless size of enterprise is expanded to the capacity of a one-man equivalent.

Projected income potentials within the capabilities of a one-man equivalent vary considerably among enterprises. For example, they range from less than $2,000 for an extensive enterprise, such as raising beef, to more than $9,000 for such enterprises as fattening beef, which can be largely automated. The significant feature, however, is the change within a given enterprise.

The following tables are presented that consider dairy cows, beef cows, steer calves, short-fed cattle, sheep, hogs, and poultry: (1) Productive Capacity of One-Man Equivalent Under Specified Levels of Efficiency and Degrees of Mechanization; (2) Estimated Livestock Income That Can Be Produced by One-Man Equivalent Under Specified Levels of Efficiency and Degrees of Mechanization; (3) Estimated Capital Requirements per Unit of Livestock for Systems Comprising Specified Degrees of Mechanization; and (4) Total Capital Requirements, Excluding Land, Needed to Provide One-Man Equivalent With Full-Time Employment in a Fully Mechanized System.

Dept. Agr. Econ., U. Ill., Col. Agr., Urbana, Ill.

McCalmont, J. R. FARM SILOS. U.S. Dept. Agr. Misc. P. 810, 27 pp. 1960.

The silo is a conspicuous building on farms in all parts of the country. Each year it is more important in supplying forage for livestock. Since 1875, when the making of silage in the United States was first recorded, the number of silos of all types has increased to more than 900,000, storing more than 70 million tons of silage. This increase has been the outgrowth of many changes in the farm situation, including: (1) An increase in numbers of livestock; (2) a decrease in pasture acreage; (3) an increase in grassland farming for soil conservation; (4) mechanization of farm operations; and (5) the growing practice of feeding greater amounts of silage. Also, farmers now recognize that the amount of protein supplement needed when feeding low- to average-quality hay or corn silage can be reduced by feeding high-protein grass silage and that ensiling is an excellent way to carry over excess feed from good years to poor years and farm periods of lush spring growth to periods of summer shortage.

In choosing a silo, consider the service requirements, the available cash and labor, initial cost of the silo, and its upkeep and efficiency in preserving forage. Losses vary with the type of silo, the crop ensiled, its stage of maturity and moisture content, fineness of chopping, and the efficiency of excluding air and water from the silage. In permanent upright silos losses range from 5 to 20 percent in gas-tight silos and from 10 to 20 percent in other types. In permanent horizontal silos losses range from 10 to 30 percent; and in temporary trench, fence, and stack silos, from 15 to 50 percent.

The type of silo that will best suit the system of cropping and feeding and that is obtainable for the funds available should be determined. Many farmers, by using a temporary silo for a few years, have accumulated sufficient capital through saving on their feed bills, to pay for a permanent silo.

Permanent tower silos built of brick, concrete, metal, or tile are attractive, durable, and fire and wind resistant. Use of unloaders and conveying systems reduces to a minimum the hand labor required for feeding.

Large tower silos ranging from 24 to 36 feet in diameter are being used to store feed for big feeding operations. Some of these have three or four sets of doorways to facilitate hand feeding, but most have only one and the silage is fed out from the center through a drag trench at the bottom. A plug 2 to 2½ feet in diameter and 6 feet long is pulled up through the center as these silos are filled. This leaves a chimneylike opening from the top to the bottom of the silo. A simple silo unloader scrapes the silage to the center, where it drops to the bottom of the silo and is delivered to feed trucks or bunks with a drag or screw conveyor.

A prefabricated porcelainized steel silo is also available. The glasslike coating is applied on both sides of the metal. This silo is airtight to prevent spoilage of the silage and is emptied from the bottom with a mechanical unloader. To maintain airtightness, the silo should be operated according to the manufacturer's recommendations. An advantage of this silo is that it can be partly loaded at intervals with different crops without appreciable loss in silage quality and with no top spoilage.

A self-feeding arrangement for upright silos is being developed. Various types of baffles and pins are used to control and limit the speed with which the silage feeds into the feed trough. No system has been developed as yet to eliminate all safety hazards and handwork in feeding, especially where the silage freezes.

Permanent horizontal silos are generally considered less attractive, but they cost less per ton of storage and offer the advantage of self-feeding with a low-cost feeding gate or mechanical feeding with the tractor loader or with an ensilage unloader.

Temporary silos are useful in an emergency and they are sometimes used when sufficient money is not available to build a more substantial structure.

ARS, USDA, Inform. Div., Washington 25, D.C.

Institutional And Educational

Food and Agriculture Organization of the United Nations. THE STATE OF FOOD AND AGRICULTURE 1960. Food and Agr. Organ. of U.N. CL 34/2, 182 pp. 1960.

World agricultural production increased about 2 percent in 1959-60 and remained somewhat ahead of the annual rate of growth of the world's population. International trade in agricultural products partly recovered in 1959 and early 1960 from the setback resulting from the economic recession of 1957-58 in the industrialized countries.

An encouraging feature of the recent situation is the renewed steady expansion of production in the Far East. It is now estimated to have improved to within 3 percent of the prewar level.

Of the other less developed regions, per caput supplies in Africa since the war appear to have remained close to the prewar level. In Latin America and the Near East there has been some increase over the level, partly because of smaller net exports of food, especially in the Near East.

Food and population are two of the crucial determinants of the future of mankind. Freedom from hunger in the less developed countries of the world, however, is not simply a matter of regaining or maintaining prewar levels of per caput production and consumption. Much greater increases in food production in these regions are needed before any real progress can be made in stamping out hunger and malnutrition. But increased food production must go hand in hand with general economic development so that consumers can afford the additional food and the better quality food they need.

In general the impact of the striking advances in agricultural science in this century has so far been largely confined to North America, Europe, and Australia and New Zealand. In these regions agricultural yields and productivity have risen rapidly since the war. In the less developed regions the increased production so far achieved has come primarily from an enlargement of the cultivated area. To release this immense potential is the central task of all concerned.

In last year's issue of this report it was emphasized that all too frequently extreme rural poverty and lack of credit, except at usurious rates of interest, prevent the great majority of farmers from adopting improved practices, even if they are aware of them. Insecurity of tenure often leaves them no real inducement to improve their holdings, while in many cases the conditions of tenure are such that the farmer himself can count on only a fraction of any additional return from an increase in output. Moreover, inadequate and sometimes inequitable marketing systems, together with uncertain and sharply fluctuating farm prices, often make it hazardous for a farmer to increase his production for sale.

The final chapter, "Programing for Agricultural Development," takes up the same theme, this time from the standpoint of governments. This chapter reviews progress during this period, drawing extensively on the experience of FAO in assisting its Member Governments both in formulating and in implementing their agricultural programs.

Agricultural programing is little more than an academic exercise unless there are good prospects that the plans can be translated into reality within the period covered by the plan. Means should be found of enlisting the co-operation of thousands, often millions of farmers. This, in turn, implies building up an effective administrative apparatus, official and nonofficial, reaching down to the farmers themselves, for the proper implementation of projects of extension, farm credit, marketing and so forth. In many less developed countries economic and social measures are necessary to give farmers greater incentives to increase food production for the market.

Unless these organizational and institutional aspects receive adequate attention, and full account is taken of the day-to-day problems of farmers arising from the environment in which they live and work development is likely to be slow. Today no country can afford to be content with slow progress.

$2.00 from Columbia U. Press, International Doc. Serv., 2960 Broadway, New York, N.Y.

Durost, D. D. INDEX NUMBERS OF AGRICULTURAL PRODUCTION BY REGIONS, 1939-1958. U.S. Dept. Agr., Agr. Res. Serv. Stat. B. 273, 37 pp. 1960.

The period since the beginning of World War II has been characterized as a period of revolution in agriculture. The combined production of crops and livestock in the United States has increased faster than has the population. From 1939-41 to 1956-58, farm output rose 43 percent compared with a 30-percent increase in population.

All major farm production regions contributed to the upsurge in production. The Northern Plains, Mountain, and Pacific States increased their volume of output by more than 50 percent.

Farm output is weighted in large degree by total crop production. In 1956-58, crop production accounted for two-thirds of the farm output of the United States as a whole and of most regions. Only in the Northeast is livestock production as important as crop production in total farm output.

Feed grains and hay accounted for 47 percent of total United States crop production in 1956-58. Corn alone contributed nearly a fourth of the total.

The relative contribution of the individual regions to total crop production of the United States varied from 5 percent in the Delta States to 24 percent for the Corn Belt during 1956-58. The combined production of the three north-central regions accounts for more than 45 percent of the United States total.

Total crop production increased 29 percent, or at an average annual rate of 1.5 percent, for the United States as a whole from 1939-41 to 1956-58. The important producing regions--the Corn Belt, Lake States, and the Northern Plains--increased production of crops at an annual rate of 1.6, 2.0, and 2.8 percent, respectively, during this period. None of the southern regions increased production as much as 1 percent annually.

Total change in crop production is a function of the change in acreage of cropland used and in crop production per acre. Acreages of cropland increased in the north-central and western regions but decreased in the Northeast and the southern regions from 1939-41 to 1956-58. For the United States as a whole, the acreage of cropland decreased slightly. But crop production per acre rose in all regions, varying from 1.1 percent annually in the Mountain States to 2.5 percent in the Southeast.

Crop production, as well as farm output, in the United States increased at a faster rate from 1939-41 to 1947-49 than from 1947-49 to 1956-58. All regions increased their total crop output during the earlier period. But in the second period, the four southern regions produced less in 1956-58 than in 1947-49. Crop production per acre for the United States increased at the same annual rate during both periods.

Livestock and livestock products account for a third of the total farm output. Production of meat animals accounted for half of the total livestock production in 1956-58. The rest is divided fairly evenly between poultry and dairy products.

The most notable change in livestock production in the last two decades has been the relative increase in poultry production. In 1939-41, poultry production accounted for only 17 percent of total livestock production. By 1956-58, it made up 24 percent. The chief reason for such a change was the rapid development of the broiler industry.

Production of meat animals is the major type of livestock production in 6 of the 10 regions. Dairy products lead in the Northeast and the Lake States, and poultry products lead in the Southeast and the Pacific States.

From 1939-41 to 1956-58, total livestock production rose more, percentagewise, than crop production. Livestock production in 1956-58 was 40 percent greater than in 1939-41. Regional annual rates of increase varied from 0.8 percent in the Southern Plains to 5.3 percent in the Southeast.

Unlike crop production and farm output, livestock production increased at a greater rate during the last half of the 1939-41 to 1956-58 period than in the first half, increasing by 2.3 and 1.6 percent annually, respectively.

The relative contribution of individual regions to total livestock production in 1956-58 varies from 4 percent in the Delta States to 28 percent in the Corn Belt. Again the three north-central regions make up by far the major producing area; they account for half of all livestock production.

Tables and graphs.

ARS, USDA, Inform. Div., Washington 25, D.C.

Fuller, W., Purnell, G., Fielder, L., Laursen, M., Beneke, R., and Shepherd, G. AN ALTERNATIVE PARITY FORMULA FOR AGRICULTURE. Iowa Agr. and Home Econ. Expt. Sta. Res. B. 476: 692-722. 1960.

The parity price ratio--the ratio between the indexes of prices received and paid by farmers--is widely used as a measure of farmers' economic status, and percentages of parity prices are used as the bases for price support operations running into billions of dollars. This report examines the parity formula, to see how well suited it is to these purposes and develops an alternative formula.

Investigation indicates that the parity ratio and parity prices for different products are not very appropriate measures, for the following reasons:

1. The original index base period, 1909-14, is out of date. A more recent base would be more appropriate.
2. The same parity index (index of prices paid by farmers) is used for all farm products in the United States. Parity prices for individual farm products would more closely reflect the parity purchasing power of those products if parity indexes were computed separately for each product.

3. The parity price ratio reflects changes in the level of the prices received relative to prices paid by farmers, but it does not reflect changes in the quantities produced or purchased.
4. The parity price ratio compares the purchasing power of farm products per unit of product (bushel, bale, etc.) with their purchasing power per unit in an earlier base period. What farmers are really interested in, however, is parity of return to their labor and management with returns in other occupations now.

In this study, the following procedures are used:

1. Parity returns to the services of capital and land are computed by multiplying the current value of the capital and land by the current Federal Land Bank interest rate.
2. Parity returns to labor are computed by multiplying the current earnings of manufacturing workers by the ratio of farm labor returns to these earnings during a recent base period.
3. Parity labor returns, parity returns to land and capital, and current operating expenses are summed to obtain "parity gross income."
4. Actual gross income is divided by parity gross income and the quotient multiplied by 100 to give the parity returns indicator. Thus, when the parity returns indicator equal 100 (i.e., when actual gross income equals parity gross income) the resources engaged in agricultural production are considered to be receiving "parity returns."

Parity returns prices are computed as a quotient of parity gross income and total production, where total production is expressed in terms of the product concerned. Thus, if the parity returns price of corn is to be determined, total production is expressed in corn value equivalents. The parity returns prices provide a set of prices which multiplied by the respective outputs, would yield parity returns. This parity returns formula was applied to data from several relatively homogenous production areas. Important corn-, wheat-, cotton-, and milk-producing areas were considered.

The parity returns indicators for the corn and wheat areas rose nearly 20 points relative to the United States parity price ratio over the period. For the cotton areas, the two series showed similar long-run trends. For the dairy areas, the parity returns indicator moved in much the same manner as the parity price ratio, until after 1952 when it rose (relatively) about 10 points.

Over the period 1930-57, the parity returns indicators for the different products varied more from year to year than the present United States parity price ratio, except for milk, which varied less.

The parity-returns prices of corn declined more than 20 percent relative to the modernized parity price over the 1930-57 period. The decline for wheat was more than 25 percent. The parity returns price for cotton rose (relatively) more than 40 percent from 1930 to 1940, but declined about 10 percent from 1940 to 1957.

Agr. and Home Econ. Expt. Sta., Iowa State U. Sci. and Tech., Ames, Iowa.

Hodges, E. F. LIVESTOCK-PRODUCTION UNITS, 1910-1958, AND CONSUMPTION OF FEED BY LIVESTOCK, 1955-1958. U.S. Dept. Agr., Agr. Res. Serv. Stat. B. 275, 31 pp. 1960.

The balance between livestock production and the feed supply is of national concern during periods of both feed surpluses and feed shortages. Livestock-production units provide a basis for estimating the approximate amount of feed that may be needed at any one time.

This is a summary bulletin of various publications on livestock-production units for the period 1910-1958, and the consumption of food by livestock for the period 1955-1958.

Tables and graphs.

ARS, USDA, Inform. Div., Washington 25, D.C.

Agricultural Research Service. CURRENT DEVELOPMENTS IN THE FARM REAL ESTATE MARKET. U.S. Dept. Agr., Agr. Res. Serv. ARS 43-133, 30 pp. 1960.

Market values of farm real estate remained essentially unchanged in about half the States in the 4 months ended July 1, 1960. At 172 (1947-49 = 100), the index was 1 percent above a year earlier. However, declines of 2 percent or more in 14 States were sufficient to reduce the national index by 1 point (0.6 percent) from the March level. The indexes for 11 States reached new peaks this July, with increases of 5 to 6 percent for the year. Largest declines, averaging about 3 percent, occurred in Michigan, Wisconsin, and Minnesota.

The total market value of farm real estate was estimated at $128.8 billion, or $111.24 per acre, on July 1, 1960. This was $300 million (0.2 percent) less than the value on March 1, but $2.2 billion more than on July 1, 1959.

The leveling off in market values in the last year is probably a readjustment in the unusual relationship that has developed since 1954 between market values and farm income. Values increased by a third in a period when net income changed very little. As a result, the price of farm real estate is currently about 9.7 times net income per acre, whereas in 1950-54, the ratio was 6.0, and in 1935-39, 6.2.

Active farmers made 63 percent of all purchases of farm real estate in 1959-60, a slightly higher proportion than in the previous year. Tenants continued to decline in relative importance as buyers, but owner-operators bought a higher proportion. Nonfarmers accounted for about a third of all purchases, slightly less than in the 4 previous years.

Additional lands acquired by farmers for enlargement of their farms have become the dominant type of land transfer in major areas of the country. In 1959-60, 45 percent of all transfers were for this purpose, compared with 42 percent in 1958-59 and 26 percent in 1950-54. In the Corn Belt and wheat areas, more than half of all land transfers were for purposes of farm enlargement.

As in the previous 4 years, two-thirds of the purchases in 1959-60 were financed with some form of credit. The proportion of all transfers financed by land contracts has doubled in the last 10 years, and in 1959-60, they were used in a fourth of all transfers. Downpayments on purchases made under contract are normally about half those required with conventional mortgage financing, and the seller can realize tax savings on capital gains.

The average indebtedness incurred in land purchases has crept slowly upward in recent years, partly as a result of the wider use of land contracts. In 1959-60, the average debt was 65 percent of the purchase price. Interest rates charged by life insurance companies and Federal land banks on farm mortgages have increased to 6 percent for most loans made currently. Less than a third of the new mortgage loans committed by life insurance companies in the first half of 1960 were for the purpose of financing the purchase of farm real estate. About half were for refinancing existing mortgages or other indebtedness.

Charts, tables, and maps.

ARS, USDA, Inform. Div., Washington 25, D.C.

Agricultural Research Service. FARM REAL ESTATE TAXES: RECENT TRENDS AND DEVELOPMENTS. U.S. Dept. Agr., Agr. Res. Serv. ARS 43-130, 14 pp. 1961.

Taxes levied on farm real estate in the United States totaled $1,192 million in 1959, an increase of $89 million, or 8 percent above the amount levied in 1958. This is the sharpest annual rise in levies on farm real estate recorded in the last decade. For the most part, these taxes are payable in calendar year 1960. In 1959, State and local tax levies on farm real estate averaged $1.11 per acre, compared with $1.03 in 1958. The index of taxes levied rose 15 points over 1958, to a record high of 199 (1946-48 = 100) in 1959.

Taxes levied on farm real estate in 1959 were higher than in 1958 in all States. The largest increases--20.1, 19.8, and 16.4 percent--occurred in West Virginia, Arkansas, and Florida, respectively. In 13 States, taxes increased by more than 10 percent; in 22 States by more than 5 percent; and in 10 States by less than 5 percent.

Taxes per acre of farm real estate averaged highest in New Jersey at $9.15, and lowest in New Mexico at $0.10. In 14 States, the average tax per acre was more than $2; in 10 States, it was between $1 and $2, and in 24 States, it was less than $1.

In recent years, the uptrend in farm taxes has been approximately matched by the rise in market values of farm real estate, with the result that taxes have held around $0.90 per $100 of full value. In the year ended March 1, 1960, the gain in value of farm real estate was about 3 percent, or only about half as much as in the 3 preceding years. As a result, the 8-percent increase in tax levies pushed the tax-to-value relationship from $0.89 per $100 in 1958 to $0.93 in 1959. This is the highest tax per $100 of full value since 1949.

Maps, tables, and graphs.

ARS, USDA, Inform. Div., Washington 25, D.C.

Maier, F. H., Maitland, S. T., and Bowles, G. K. THE TENURE STATUS OF FARMWORKERS IN THE UNITED STATES. U.S. Dept. Agr., Agr. Res. Serv. Tech. B. 1217. 91 pp. 1960.

The people of the United States are closer to their farm-tenure goal of owner-operated family farms than ever before. From 1880 to the 1930's, for the country as a whole, the tenure status of farm people slowly but continuously moved away from the ideal of farm-owner-operatorship. In 1880, about 55 percent of the adult male agricultural work force were owner-operators. By 1930, the comparable figure had dropped to 40 percent. During the 1930's, a dramatic reversal occurred in the half-century trend away from owner-operated family farms. By 1950, owner-operators again made up about the same proportion of the adult male farm work force as in 1880. Between 1950 and 1955, apparently, the proportion of owner-operators increased further.

These data suggest several questions about the forces behind the farm-tenure conditions that existed during the period and the trends that developed. The study reported attempts to answer these major questions: Over the years why have owner-operators not made up a larger proportion of the adult male agricultural work force? After the 1930's, what forces reversed the previous half-century trend away from owner-operated family farms? What farm-tenure developments may be expected in the future?

ARS, USDA, Inform. Div., Washington 25, D.C.

Metzler, W. H., and Sargent, F. O. MIGRATORY FARMWORKERS IN THE MIDCONTINENT STREAMS. U.S. Dept. Agr., Agr. Res. Serv., Prod. Res. Rpt. 41, 62 pp. 1960.

The annual movement of migratory farmworkers from southern Texas to seasonal work areas in more than 30 States appears to be an established phase of our agricultural economy. Yet the position of these workers in this broad labor market is precarious. Changes in production areas and in harvesting methods and competition from other sources of labor tend to shift the areas of need, to reduce the length of the work season, and to curtail the need for these workers.

The companies and organizations that initiated and promoted this movement are still active. Both sugar-beet companies and cotton producers look forward to the day when they need not depend on a large seasonal labor force. The many smaller operators in the work areas will continue to depend each year on seasonal labor supplies, and they have neither the organization nor the funds for intensive recruiting of labor. The role of State employment services in this movement is certain to increase.

The workers who engage in this movement of migrants from southern Texas are usually referred to as Spanish-Americans. Almost three-fourths of them were born in the United States of Mexican ancestry. Approximately 40 percent of the heads of households migrated to Texas from Mexico.

Formerly, these migrants needed a crew leader or spokesman to make their job contacts; now 60 percent of them travel in family groups in their own cars and make their own work arrangements.

The migratory workers can be classified into three major groups of approximately equal size according to their range of movement. One group moves within the State only and engages chiefly in picking cotton. Another group migrates to the sugar-beet, vegetable, and fruit areas around the Great Lakes, in the Rocky Mountain area, or along the Pacific coast. The third group also works in these out-of-State areas but cuts its work there short in order to engage in the cotton harvest in Texas.

These workers showed considerable skill in the timing and direction of their movement and haphazard travel was the exception. A third of them worked in only one area away from the home base, and a fourth worked in only two areas. Yet practically all were underemployed. During 1956, they averaged only 131 days of work. Heads of households averaged 174 days. The unemployment rate while these workers were at home base was twice as great as when they were on the road.

Average earnings per worker during 1956 amounted to $779, but male heads of households averaged $1,145. Average earnings per family varied according to the size of the family work force; they averaged $2,208. Less than one-fourth of this was earned at the home base.

The families of these workers are large, averaging 6.5 members, and they possess a high degree of solidarity. More than half of the migrants are children below legal working age. It is customary among these families for all children to help in whatever tasks need doing. This results in irregular schooling. Practically all the children are educationally retarded.

Apparently size of family is associated with the need to migrate. When the family becomes too large for the earnings of one worker to support all its members, the household head looks for work that will permit other members to contribute to the family income. Conversely, families stop migrating when enough members obtain local employment and it no longer pays to migrate.

Certain trends are helping to alleviate the problems associated with this movement: (1) The permanent movement of migratory workers to the work area and reduction of labor surpluses at the home base during the winter; (2) development of annual worker plans so as to correlate movement of the workers with local labor needs in any particular season; (3) development of day-care centers, summer schools, and other facilities to take care of the children who accompany the workers; (4) improvement in methods of teaching English to Spanish-speaking children; (5) more regular school attendance and increased educational attainment; and (6) improvement in transportation, housing, and sanitation to bring the living and working conditions of these people more in line with the norms of American life.

Problems of child support, regulation of child labor, and maintenance of educational opportunity are important aspects of this migratory movement.

As a dependable work force is vital to the agriculture of seasonal areas, long-range policies to build up and increase such a force are needed. Due attention to regularity of employment, competitive pay scales, acceptable transportation and housing standards, and the development of an expanded local labor supply should help to achieve this result.

ARS, USDA, Inform. Div., Washington 25, D.C.

Smith, W. G., and Heady, E. O. USE OF A DYNAMIC MODEL IN PROGRAMMING OPTIMUM CONSERVATION FARM PLAN ON IDA-MONONA SOILS. Iowa Agr. and Home Econ. Expt. Sta. Res. B. 475: 667-687. 1960.

A sequence of yearly plans which provide optimum 5-year farm programs for a 160-acre farm under three alternative conservation situations was studied. The 169-acre farm is located on the Ida-Monona association of western Iowa. In each of the 5-year plans, family living or household consumption is considered to be an "exogenous" activity because and "exact" capital allowance for this activity must be met each year. Family living, therefore, competes with farm production in the use of available operating capital. In each optimum plan, capital generated from crop and livestock production in any one year is used for farm production and household consumption for the following year. Dynamic linear programming is used to obtain the optimum farm plans.

Two dynamic linear programming models (the expansion model and the rotation model) were developed. Each model allows the programming of years of activities and restrictions. The models, therefore, should extend the magnitude of farm problems which can be analyzed by dynamic programming approaches.

The three conservation situations studied are as follows: (1) A 160-acre farm on which crops are not assumed to be fertilized and cropland is not assumed to be terraced and contoured; (2) the same as (1), except crops are assumed to be fertilized; and (3) a 160-acre farm on which crops are assumed to be fertilized and cropland is assumed to be terraced and contoured.

The various soil types on the 160-acre farm are combined to form two soil productivity class, and Land A, a "low" productivity class, and Land B, a "high" productivity class.

Net returns for the 5-year period were highest when fertilizer and terracing and contouring were included. Returns were lowest when neither fertilizer nor terracing and contouring were included. The inclusion of crop fertilization increased total farm returns much more than did the inclusion of terracing and contouring of cropland. Return per $1 on investment was greatest, however, for terracing practices and the farm reorganization attached to them.

Agr. and Home Econ. Expt. Sta., Iowa State U. Sci. and Tech., Ames, Iowa.

Haren, C. C. CONSERVATION FARMING IN SELECTED AREAS OF THE SOUTHERN PIEDMONT. U.S. Dept. Agr., Agr. Res. Serv. 43-120, 59 pp. 1960.

Approximately 80 percent of the survey acreage in Spartanburg County, S. C., and Walton County, Ga., is capable of development for farming purposes. About a fourth of the total could be used safely for row crops each year, and more than half for other crops or pasture. The rest is suited chiefly to timber production and related uses or is occupied by farmsteads and other miscellaneous uses.

Part of the land withdrawn from farming before 1953 was steep, eroded, or otherwise unsatisfactory even for pasture. Much of the other land in woods or open but unused for crops or pasture in 1953, would be of limited value for cotton or corn. But it could be redeveloped for production of winter grains, hay or forage, or to supply pasture or grazing for dairy or beef cattle.

In 1955, a high percentage of the land diverted from cotton as a result of the reapplication of allotments was used for other crops or shifted to pasture. A reduction of about 25 percent in the acreage of crops for harvest in 1958 stemmed mainly from the temporary assignment to the Acreage Reserve of most of the acres allocated to cotton. Although some crop and pasture fields were turned out or planted to protective crops for other reasons, nearly as many acres were restored to farming.

A major reduction in the number of acres planted to cotton, combined with a slight decrease in the acreage of corn, was reflected in a decline in the percentage of the cropland in row crops from about two-thirds in 1953 to a third in 1958.

Often, choices of land, both for cotton and for setting aside in the Acreage Reserve were limited by the quality of the open land available in relation to the operator's requirements for cotton, other crops, and pasture.

Recent and prospective changes in ownership and operation are paving the way for overcoming traditional obstacles to a more complete as well as conservational use of the land resources in the survey and adjacent areas.

Further improvements in yields per acre of corn and other crops and in carrying capacities of pastures would help to meet the expanding demands for feed and roughages in these and neighboring States. Of equal importance, greater yields and carrying capacities per acre would enable additional operators, who were previously handicapped by lack of sufficient land, to shift partly if not completely from cotton.

Progress has been made in diversifying operations and adopting other conservation practices in the survey areas by farmers who have been in position to replace all or most of their cotton with other crops or improved pasture, either with or without buying more land. Elsewhere, progress has been retarded by the necessity for continuing to rely on cotton as the chief or an important source of income, and by inability to fully develop potentials for other crops and pasture, or to plant protective crops or trees on land not needed for agriculture in the immediate future or of little if any economic value for farming purposes.

ARS, USDA, Inform. Div., Washington 25, D. C.

Loftsgard, L. D., and Griffing, M. E. FARM PLANNING GUIDES FOR CENTRAL NORTH DAKOTA. N. Dak. Agr. Expt. Sta. B. 425, 32 pp. 1960.

A linear programming analysis was used to determine the most profitable crop and livestock organization for various farm situations in central North Dakota. This study was designed to furnish farm planning guides and to illustrate principles of optimum resource use.

Farm plans were computed for a 640 acre farm and a 960 acre farm. Also, some analyses were made concerning the profitability of investing in added acreage compared with a more intensive farming system on the original acreage.

Nineteen crop rotations, each with three levels of fertilizer use, and 10 livestock enterprises were considered as the production alternatives for both farm sizes.

When a cash market of $12 per ton was assumed for alfalfa hay, the wheat-barley-alfalfa-alfalfa/fallow rotation fertilized at a high rate was the most profitable cropping program for both farm sizes and for all levels of operating capital.

With hay sold for the cost of its production, the most profitable land-use program was a wheat-barley-flax-alfalfa/fallow rotation.

However, when there was enough operating capital to include livestock in the farm plan, the least cost means of obtaining extra forage was by shifting sufficient acreage from the latter rotation to the wheat-barley-alfalfa-alfalfa/fallow rotation. The least cost of obtaining extra feed grain for the livestock was by including a wheat-barley-oats-alfalfa/fallow rotation in the farm plan.

For all farm situations considered, the first increments of operating capital returned highest total profits when used for a high fertilization cropping program. Livestock was not included in the maximum profit plan until the supply of operating capital was greater than required for intensive crop production.

If a grade A milk market existed, dairy cows were included in the optimum farm plan for the 640 acre farm but not for the 960 acre farm. Instead, a sheep ewe flock was the predominant livestock enterprise for the larger farm. A sheep ewe flock outbid dairy cows for the use of resources on the smaller farm when hay was valued at less than $12 per ton.

For high levels of operating capital, a deferred-fed calf enterprise was included in the farm plan in addition to the dairy herd or the sheep ewe flock.

When maximum amounts of operating capital were used, a feeder lamb enterprise replaced beef feeding because the limiting amounts of feed and labor allowed a relatively higher investment in feeder lambs than in beef, except when the value of hay was assumed to be equal to its cost of production. Then, highest total profits were realized by not including feeder lambs in the farm plan but by increasing the number of beef feeders.

Optimum farm plans were determined for one farm situation where extra land could be purchased for $65 per tillable acres.

N. Dak. Agr. Expt. Sta., Fargo, N. Dak.

BIOLOGY

Fish

Moyle, J. B., and Clothier, W. D. EFFECTS OF MANAGEMENT AND WINTER OXYGEN LEVELS ON THE FISH POPULATION OF A PRAIRIE LAKE. Trans. Amer. Fisheries Soc. 88: 178-185. 1959.

Take of carp by annual intensive winter seining from Lake Traverse, a shallow 11,000-acre lake, declined from 58,000 to 500 lbs. per seine haul during the period 1951-1958. Concurrently, the catch of crappies, which were returned to the lake, rose from 2 to 84 thousand fish per haul. Bullheads were also removed, mostly by hoopnets, in amounts ranging from 7 to 56 lbs. per acre per year with greatest removal in 1956-57.

Average catch per hoopnet pocket was 25.3 lbs. in 1950-53 and 65 lbs. in 1956-58.

Walleyes, mostly as fry, were stocked in all 13 years of the 1945-1958 period considered and northern pike and rescued black crappies in some of these years. It appears from consideration of winter oxygen levels and subsequent take of game fish in seines that walleyes (and probably channel catfish and bluegills) did not survive as well at winter oxygen levels below 5 p.p.m. as above this level. Northern pike, crappies, and rough fish were more tolerant and evidently survived well when oxygen levels fell to near 1 p.p.m.

Minn. Dept. Conserv., St. Paul, Minn.

Hulsey, A. H. A PROPOSAL FOR THE MANAGEMENT OF RESERVOIRS FOR FISHERIES. Proc. Twelfth Annual Conf. Southeastern Assoc. Game and Fish Comm. Oct. 19-22, 1958. pp 132-143. 1958.

A fisheries management plan for reservoirs is proposed which is dependent upon having a fish management pool and provision for drainage incorporated into the basic design. Justification is given to support the cost of having a cleared management pool in the bottom of the reservoir as well as drainage facilities. A plan is also proposed for selective clearing of reservoir basins.

A management program described is based on a philosophy of drastic manipulations of fish populations through fall and winter drawdowns, selective kills, partial kills, intensive sport and commercial fishing, and other management practices designed to favor the carnivorous fishes and reduce the total number and lbs. of all fish so as to bring about a balance of the predator fishes with their food supply and maintain expanding fish populations.

The drawdown is of paramount importance in the reservoir management scheme and, in the humid Southeastern United States, it should begin immediately after Labor Day. The water level should be lowered to the fish management pool by October 15th or November 1st. According to the size of the watershed, water levels can be allowed to return to normal after January 1st. Cost of carrying out the management techniques in the fish management pool are minimal and most effective.

Ark. Game and Fish Comn., Lonoke, Ark.

Warner, K., and Porter, I. R. EXPERIMENTAL IMPROVEMENT OF A BULLDOZED TROUT STREAM IN NORTHERN MAINE. Trans. Amer. Fisheries Soc. 89: 59-63. 1960.

Brook-trout habitat in Big Hudson Brook was destroyed in 1950 by extensive bulldozing in preparation for pulpwood driving. Following bulldozing, the brook had no well-defined channel at low water levels, water temperatures reached the mid-seventies, and the small flow seeped through bottom rubble. Although restoration of original habitat conditions was impossible, an attempt was made, using a bulldozer, to improve trout-stream habitat that had been destroyed earlier by bulldozing. Seventy-one wing deflectors, 10 rock dams, and 6 spring holes were created by a single bulldozer in 3 working days. Evaluation of the work 2 years later showed that 63 deflectors had successfully narrowed stream flow or created pools, rock dams were largely unsuccessful, and pools created by excavation of spring areas commonly harbored trout during warm summer weather.

The authors concluded that in Maine, where many miles of once productive trout stream have been destroyed by bulldozing, chosen areas of these small streams can be benefited by construction of planned stream improvement structures using a bulldozer.

Dept. Inland Fisheries and Game, Augusta, Maine.

Stoeckeler, J. H., and Voskuil, G. J. WATER TEMPERATURE REDUCTION IN SHORTENED SPRING CHANNELS OF SOUTHWESTERN WISCONSIN TROUT STREAMS. Trans. Amer. Fisheries Soc. 88: 286-288. 1959.

Late afternoon summer water temperatures at the mouth of a spring channel on a trout stream near La Crosse in southwestern Wisconsin were reduced by 10° to 11° F. by shortening the channel 67 percent and routing the water through a willow-shaded location.

Lake States Forest Expt. Sta., FS, USDA, St. Paul, Minn.

Grice, F. ELASTICITY OF GROWTH OF YELLOW PERCH, CHAIN PICKEREL, AND LARGEMOUTH BASS IN SOME RECLAIMED MASSACHUSETTS WATERS. Trans. Amer. Fisheries Soc. 88: 332-335. 1959.

To evaluate the Massachusetts warmwater pond and lake reclamation program, which began in 1952, age and growth studies were made on several species of fish. After reclamation by rotenone, growth rates of yellow perch, chain pickerel, and largemouth bass were found to be more rapid than under natural conditions and in some cases growth rates exceeded those recorded in the literature. Adult fish stocked after reclamation showed marked increase in growth, as did resident adult fish remaining after thinning of the population. Rapid growth in reclaimed waters is attributed to reduced competition for food because of lower population densities. In these ponds it appears that the rate of growth of yellow perch, chain pickerel, and largemouth bass was more dependent upon population density than upon length of growing season or other factors.

Mass. Div. Fisheries and Game, Westborough, Mass.

Lambou, V. W. FISH POPULATIONS OF BACKWATER LAKES IN LOUISIANA. Trans. Amer. Fisheries Soc. 88: 7-15. 1959.

Fish populations in seven backwater lakes were sampled by rotenone poisoning. On the average, 397 lbs. of fish per acre comprising 103 lbs. of game fish and 169 lbs. of commercial fish were recovered from the lakes. Recoveries from individual lakes ranged from 142 to 651 lbs. of fish per acre. Non-predaceous fish made up 56 percent of the total population. Bluegill sunfish, warmouth sunfish, gizzard shad, fresh-water drum, largemouth bass, black crappie, and spotted gar were the principal fishes in the lakes. An average of 78 lbs. of available game fish (harvestable-size game fish) per acre was recovered from the lakes. Fairly large concentrations of fish occurred in relatively small areas in some of the backwater lakes. A total of 974 lbs. of fish, of which 475 lbs. were game fish was recovered from a single 1 acre sampling area.

On the average, there were 1.9 lbs. of non-predaceous fish per lb. of predaceous fish. There were considerably less available forage fish (by weight) for the predators than they themselves made up in the population. The predaceous fish in the backwater lakes must be partly dependent on some type of forage other than fish, and swamp crayfish are probably important in their diet.

A large increase in the area of the lakes during high water periods in the spring creates a favorable habitat for a rapidly expanding fish population. The quality of the sport fishing on the backwater lakes is excellent.

La. Wild Life and Fisheries Commission, Baton Rouge, La.

Turner, W. R. STANDING CROPS OF FISHES IN KENTUCKY FARM PONDS. Trans. Amer. Fisheries Soc. 89: 333-337. 1960.

Estimates of standing crops of fishes in 22 Kentucky farm ponds were made during the summers of 1956, 1957, and 1958. The studies were essentially limited to ponds containing populations of largemouth bass (Micropterus salmoides), bluegill (Lepomis macrochirus), and/or green sunfish (Lepomis cyanellus). Prior to treatment with rotenone, fish were captured by seining, fin-clipped, and returned to the pond. The total standing crops were calculated from the percentages of fin-clipped fish recovered following the total eradication of each fish population. Standing crops of fish in the 22 ponds ranged from 73 to 770, and averaged 385 lbs. per acre. Nine ponds contained balanced, while 13 contained unbalanced fish populations. F/C ratios in the balanced populations ranged from 1.6 to 8.0 and averaged 4.6, while in the unbalanced populations they ranged from 4.1 to 37.7, and averaged 16.6. In the nine ponds containing balanced populations there was an average standing crop of 282 lbs. of fish per acre, and 48 percent (130 lbs. per acre) of that weight was composed of harvestable-sized fish. In the 13 ponds containing unbalanced fish populations there was an average standing crop of 456 lbs. per acre, of which only 15 percent (70 lbs. per acre) was composed of harvestable-sized fish. There was a relatively high positive correlation between the size of the standing crops and the total alkalinities in the ponds (r = 0.67). There was a positive correlation between the size of the standing crops and the amounts of potassium (r = 0.44) and phosphorus (r = 0.72) present in the soils of the watersheds.

Ky. Dept. Fish and Wildlife Resources, Frankfort, Ky.

Beall, H. B., and Wahl, R. W. TRAPPING BLUEGILL SUNFISH IN WEST VIRGINIA PONDS. Prog. Fish-Culturist 21: 138-141. 1959.

Simple wire traps of either the Carlander or cylindrical design are effective in removing bluegills from farm ponds. Alteration of the traps by adding wings, a lead, or by covering with brush seems to have no effect on the catch. Cottage cheese suspended in a mesh bag within the trap increases trapping efficiency. Traps selective for intermediate-size bluegills can be constructed by using 0.75-inch mesh hardward cloth and setting the throat opening at about 2.25 inches. By trapping continuously, a pond owner might expect to remove 20 or 30 percent of a bluegill population from a pond in 4 to 6 weeks.

Conserv. Comn. W. Va., Charleston, W. Va.

Tanner, H. A. SOME CONSEQUENCES OF ADDING FERTILIZER TO FIVE MICHIGAN TROUT LAKES. Trans. Amer. Fisheries Soc. 89: 198-205. 1960.

Inorganic fertilizer was applied to four of a group of six Michigan trout lakes. The thermocline in the three lakes receiving the most fertilizer shifted to a more shallow position. Three of the fertilized lakes decreased in total alkalinity at a greater rate than did the two lakes not fertilized. Fertilization resulted in the oxygen being depleted from the hypolimnion and some oxygen reduction occurred in the thermocline. The volume of oxygenated water remaining under the ice during the critical period of late winter was reduced in the fertilized lakes, and lakes fertilized at the highest rate very nearly approached winterkill conditions. The reduction of oxygen both in summer stagnation periods and in late winter was more severe after the second season of fertilization.

Colo. Coop. Fishery Res. Unit, Colo. State U., Fort Collins, Colo.

Swingle, H. S. PLANT FOOD FISH FOOD FISH. Plant Food Review 6(3): 4-5, 24. 1960.

Fish farming has become a $20 million business in the United States. This is the first of two articles describing the contribution that fertilizer has made to this rapidly expanding industry.

Fertilization of ponds used for fish production and for sport fishing has become standard practice in the Southeast for a number of reasons: (1) Plant food applications increase fish production from 100 to 200 percent, thus making possible a greater return on the investment in pond construction; (2) it greatly reduces or prevents growth of rooted pond weeds in areas where the depths of water are greater than 18 inches; (3) fertilization greatly reduces mosquito population by the elimination of most pond weeds that harbor mosquito larvae and prevent fish from eating them; and (4) since fertilization assists the growth of floating microscopic plants instead of rooted vegetation, it aids in maintaining proper balance in the fish populations.

The most effective fertilizer mixtures for ponds should supply the following amounts of available nutrients per surface acre of pond: 8 lbs. N, plus 8 lbs. P_2O_5, plus 2 lbs. K_2O.

Ponds may be fertilized by broadcasting the fertilizer in areas where the water depth is 2 to 4 feet. It should not be placed in deeper water because deep waters are often stratified in summer and do not mix with the surface waters. Consequently, the fertilizer placed there would not be used until the fall turnover, which usually occurs in October or November in the Southeast.

A new method of fertilization developed at Auburn consists of placing the fertilizer on a wooden platform 1 foot under water. Water currents generated by light winds carry the dissolved fertilizer to all areas of the pond. One platform is sufficient to fertilize up to 15 acres of water.

Very few species of fish eat the microscopic plants produced by fertilization. These plants provide food for water fleas, insects, and the other aquatic animals, upon which bluegills, shellcrackers, catfishes, and similar fishes feed. These, in turn, furnish food for predator fish such as bass--and for human consumption. Thus, the "house-that-Jack-built" chain reaction resulting from pond fertilization is completed.

Unfertilized ponds in the Southeast yield from 5 to 40 lbs. of fish per acre per year to hook-and-line fishing. The average catch is approximately 15 lbs. annually. However, results of extensive tests show that fertilized ponds yield from 100 to 300 lbs. of fish per acre, with the average catch ranging between 150-170 lbs. annually.

Auburn U., Auburn, Ala.

Toth, S. J., and Smith, R. F. SOIL OVER WHICH WATER FLOWS AFFECTS ABILITY TO GROW FISH. N. J. Agr. 42(6) 5-11. 1960.

Lakes and streams can be considered to be solution cultures which receive nutrient elements and bases from the soil in which they are located or through which they flow.

On the basis of the chemical composition of soils of New Jersey, it is possible to classify the soils of the State into three broad groups. These are: soils of the residual and glaciated regions, soils of the inner coastal plains, and soils of the outer coastal plains.

Waters located in soils that are of glacial or residual origin have a high fish productivity rating since the soils contain moderate to high supplies of nutrient elements and bases. Waters located in soils that originate from sediments of the inner coastal plain have a fair rating and those of the outer coastal plain a poor fish productivity rating.

Similar information can be obtained by comparing the alkalinity of lakes and ponds that have been inventoried by the Lake and Pond Survey Unit. All available information has been classified into three groups based upon their location in the three soil areas.

Another means of examining the relationship between the chemical composition of soils and that of waters located in them is to determine the fish productivity of the waters. All such information has been classified into three groups based upon lake and pond location in the three soil areas into which the State has been divided. Table 1 lists this information in terms of pounds of fish per acre.

TABLE 1.--Acre Yields of Fish From Typical Soil Areas

Location	Yields	
	Range	Mean
	(pounds)	
North	106-432	220
Inner Coastal Plain	16-186	110
Outer Coastal Plain	13-64	30

A knowledge of the composition of soils and of waters in an area is of value in explaining problems that are often related to fish kills. Since waters found in the outer coastal plain area are low in nutrient elements and bases, it is possible to modify the chemical environment by liming and adding fertilizers.

Lime is used to aid bases and to correct the acidity of the water, and a complete fertilizer is applied to serve as a source of nutrient elements. One or two applications of lime are needed annually plus the usual fertilization. Fish production has usually increased in ponds treated in this fashion and has often attained a high level. Unfortunately, the liming and fertilizing of acid ponds is limited to those of rather small size. Larger impoundments usually have a high rate of water turnover, and induced changes in chemical environment are not economical.

Certain acid farm ponds located in the inner coastal plain area will respond to alkalization and fertilization but tend to deteriorate rapidly after treatment. Waters such as these usually contain high concentrations of soluble iron, aluminum, and sulfuric acid. Ponds of this type are usually established in areas containing "Black Marl" which contain iron sulfide, which upon exposure to air oxidizes to iron sulfate and sulfuric acid. The resulting acidity is great enough to solubilize large amounts of aluminum and iron, and the former is quite toxic to fish and aquatic life of all types. Ponds of this type require a treatment with superphosphate prior to liming. The aluminum phosphate formed as the pH is raised by liming, does not become solubilized as readily as does aluminum hydroxide which is formed by liming alone. Suggested rates of application of 20 percent superphosphate to remedy this condition are 50 to 75 pounds an acre foot of water, depending upon the aluminum content of the water. Spoil banks surrounding ponds of this type should also be phosphated and limed to prevent the entry of sulfuric acid and soluble aluminum into the pond by surface water runoff.

While liming and fertilizing large bodies of acid waters or acid streams is not practical, it may be possible to create a favorable chemical environment in short stretches of acid streams by using relatively insoluble materials that supply bases and some or all of the needed nutrient elements. Clam and oyster shells have been used for this purpose, but although calcium and magnesium are supplied to the waters as the shells become slowly soluble, nutrient elements such as nitrogen, phosphorus, and potash are not added in sufficient quantities to affect the productivity of the water. Open hearth furnace slag is neutral or slightly alkaline in reaction and contains calcium, magnesium, potassium, and phosphorus. Use of this material in riffle areas, and the placement of large chunks to form small dams in acid streams, may create short stretches of water suitable for stocking trout.

N. J. Agr. Expt. Sta., Rutgers, The State U., New Brunswick, N. J.

McCarraher, D. B. THE NORTHERN PIKE-BLUEGILL COMBINATION IN NORTH-CENTRAL NEBRASKA FARM PONDS. Prog. Fish-Culturist 21: 188-189. 1959.

To evaluate the pike-bluegill combination in small impoundments, two ponds in north-central Nebraska were selected for the experiment in 1955. The results of this combination as reflected in each pond are discussed and conclusions suggested.

From this study the authors concluded: (1) Northern pike-bluegill combinations in farm ponds produced quality pike fishing. (2) Natural reproduction of the pike occurred in both ponds, a condition which should preclude annual hatchery releases. (3) Bluegill spawners released in the spring with pike fingerlings provided abundant forage throughout the year for the pike. No evidence of excessive utilization of young-of-the-year bluegills by pike was observed. (4) Demands for irrigation water and a subsequent summer drawdown of 4 to 8 feet did not impair the recruitment of the bluegills nor disturb the feeding habits and growth of the pike. (5) Growth rates of farm-pond pike, though averaging less than the growth increment recorded for Nebraska's sandhill lakes, still exceeded bass and catfish growth in similar ponds. (6) Some evidence suggested that the majority of the adult pike attempted to spawn in the feeder creek and springseep areas of the ponds. And (7) pike fishermen may expect to harvest approximately 44 percent of the pike stocked as fingerlings, at a rate of 111 to 118 fish per surface acre. It is doubtful that increased stocking of fingerlings will substantially increase the rate of harvest.

Nebr. Game, Forestation, and Parks Commission, Bassett, Nebr.

Hall, J. F. FINAL REPORT ON THE SUCCESS OF LARGEMOUTH BASS-BLUEGILL AND LARGEMOUTH BASS-SHELLCRACKER RATES AND RATIOS IN KENTUCKY FARM PONDS. Proc. Twelfth Annual Conf. Southeastern Assoc. Game and Fish Comn. Oct. 19-22, 1958. pp. 91-116. 1958.

In order to test the relative success of various stocking rates of largemouth bass, (Micropterus salmoides Lacepede)-bluegill, (Lepomis macrochirus Rafinesque), combinations and largemouth bass-shellcracker, (Lepomis microlophus Gunther), in farm ponds in Kentucky, 574 ponds were stocked with these fishes in the following combinations and rates: fry bass: fingerling bluegill 30:400, 50:500, 80:500, and 100:500 per acre; fry bass: adult bluegill 100:30, 100:50, and 100:70 per acre; fry bass: fingerling shellcracker 50:300 and 50:600 per acre; fry bass; fingerling shellcracker + mosquito fish, (Gambusia affinis Baird and Girard), 50:300 + 400 and 50:600 + 400 per acre.

In each year from 1952 through 1956, a series of ponds was stocked. No pond was stocked more than once nor with more than one rate. Bass-bluegill combinations were stocked in each of the first four years, the shellcracker combinations in 1953, 1955, and 1956.

Each pond was investigated annually and the success of each rate was determined by the percentage of balanced ponds that the rate produced.

No significant differences in percentage of success were found among the following bass-bluegill rates: 80:500, 100:500 (fry bass: fingerling bluegill), 100:30, 100:50, and 100:70 (fry bass: adult bluegill).

The most successful bass-shellcracker rate could not be determined because of the large number of ponds that failed to produce reliable data.

A total of 384 or 66.9% of the ponds stocked failed to yield reliable data and were discontinued during the investigation. The invasion of the ponds by other fish was the principal reason that these ponds were discontinued.

Dept. Fish and Wildlife Resources, Frankfort, Ky.

Swingle, H. S. COMPARATIVE EVALUATION OF TWO TILAPIAS AS PONDFISHES IN ALABAMA. Trans. Amer. Fisheries Soc. 89: 142-148. 1960.

The Java tilapia (Tilapia mossambica,) is a very efficient pondfish. Total production in ponds stocked with brood fish varied with different rates of feeding from 1,477.1 lbs. per acre in 168 days to 4,383.9 lbs. per acre in 191 days. Total production varied from 771.1 lbs. per acre in 123 days in ponds stocked with 4,000 fingerlings to 2,945.7 lbs. per acre in 111 days in those stocked with 20,000 fingerlings. The Nile tilapia (Tilapia nilotica) in limited tests with feeding yielded a maximum of 4,003.7 lbs. per acre in 208 days with adult stocking and 2,380 lbs. per acre in 113 days with a stocking of 16,000 fingerlings. Combinations of largemouth bass (Micropterus salmoides) and the Java tilapia produced a higher percentage of harvestable-sized tilapia (6 inches or more) and a smaller total production than tilapia used alone. Highest production of harvestable fish was obtained by delaying stocking of bass until August, when many tilapias were too large to be eaten. Tilapias spawned when stocked into established bass-bluegill populations, but very few young survived. Tilapias hatched late in April or early in May reached sizes from 6 to 8 inches within 3 months when adequately fed. The channel catfish (Ictalurus punctatus), the Java tilapia, and the Nile tilapia were almost equally efficient in food conversion and were superior to common carp (Cyprinus carpto), and the speckled bullhead (Ictalurus nebulosus marmoratus). Maximum productions of harvestable fish per acre during one growing season in Alabama were 2,453.1 lbs. with the Java tilapia within 119 days, 2,233.6 lbs. for the Nile tilapia within 113 days, and 2,363 lbs. for the channel catfish within 252 days. Increasing rates of stocking of fingerling tilapias decreased rates of reproduction, indicating possible presence of a repressive factor affecting reproduction. The Nile tilapia appeared to be more readily affected and populations of this species contained a higher percentage of harvestable-sized fish than the Java tilapia. Ponds stocked with brood tilapias April 15 to 20, were opened to fishing the following August. The maximum catch per acre was 593.6 lbs. in 1957 and 590.6 lbs. in 1958 in ponds stocked with the Java tilapia. The Nile tilapia grew to larger size but were less readily caught by fishermen. The catch of this species was only 128 lbs. in a pond containing 1,621 lbs. of harvestable tilapia per acre.

Tests at Auburn in aquaria in a cold room indicated that the Java tilapia ceased feeding at temperatures below 60° F. and died at 48° F. (Kelly, 1957). It was, therefore, evident that this species could not survive average winters outdoors in the Southeast, north of central Florida. Consequently, it appeared perfectly safe to use this species widely in various experiments without danger of its becoming a nuisance species.

Agr. Expt. Sta., Ala. Polytech. Inst., Auburn, Ala.

Prather, E. E. THE USE OF CHANNEL CATFISH AS SPORT FISH. Proc. Thirteenth Annual Conf. Southeastern Assoc. Game and Fish Comn. Oct. 25-27, 1959. pp. 331-335. 1959.

The channel catfish (Ictalurus punctatus) has proved to be a very promising sport fish in ponds. Fingerlings stocked in February 1958 in a 12.4-acre pond at the rate of 2,000 per acre in combination with fathead minnows and largemouth bass, and given supplemental feeding daily except Sunday, averaged 0.7 lbs. by September. During the following periods, September 24 to December 8, and March 14 to October 6, fishermen caught per acre 1,292.5 lbs. of channel catfish, 36.9 lbs. of largemouth bass, and 27.0 lbs. of miscellaneous sunfish. The number of fishing trips per acre averaged 579 with a catch of 2.3 lbs. per trip. Fishermen harvested 62 percent of the catfish stocked.

The pond was drained November 17, 1959, and 180 channel catfish weighing 391.2 lbs., 51 largemouth bass weighing 34.5 lbs., 907 fathead minnows weighing 2.4 lbs., and 80.2 lbs. of "wild" fish were recovered per acre.

The mortality of the channel catfish was 29 percent, which is about 20 percent higher than in ponds that are not fished.

The channel catfish reproduced very little and less than one young catfish per acre was present when the pond was drained.

At $1 per fishing permit, fishermen paid 35 cents to $2.41 per lb. for the catfish they caught; the average price paid was 46 cents per lb. The costs of production for fertilizer, feed, and fingerlings was 37 cents per lb.

The income per acre from fishing was $593.37, and the income from 391.2 lbs. of catfish recovered when the pond was drained was $140.83 (234.7 lbs. dressed weight at 60 cents per lb.). This provided a total income of $734.20. The total cost per acre for fertilizer, feed, and fingerlings was $481.46. This leaves a return of $252.74 per acre for labor and capital.

Agr. Expt. Sta., Auburn U., Auburn, Ala.

Andriano, D. THE PARADOXICAL BROWN TROUT. Utah Fish and Game 16(8): 8-9. 1960.

The Utah State Department of Fish and Game has adopted the following policy in regard to brown trout:

A. Streams:
   1. Brown trout are not stocked in high-elevation streams. These streams are generally more conducive to other trout species.
   2. Brown trout are not stocked in streams which are suitable for successful reproduction of other trout species.
   3. Brown trout are introduced primarily into streams which are incapable of natural reproduction of the other trout species. Generally these streams are stocked with plants of relatively large numbers of catchable-size trout as well. The large stocked trout are not subjected to any appreciable predation by the brown trout. Under these conditions the brown trout becomes, literally speaking, a free bonus fish for the angler.
   4. Brown trout are usually introduced as advanced fry and fingerlings. Plants are made during two or three consecutive years to give the species every opportunity to establish itself. Once established, stocking of these areas with brown trout is discontinued unless special investigations dictate otherwise. If this species cannot establish and maintain itself after it has been given ample opportunity, the brown-trout program is abandoned and the stream fishing is provided with catchable-size (usually rainbow) fish, which are more easily reared at lower costs in the hatcheries.

B. Lakes: Brown trout are not being stocked into any of the lakes of the State, unless it is found that conditions are unsuitable for other trout species, but suitable for brown trout. The reasons for the above are:
   1. Lakes are usually stocked with fry and fingerling trout of other species because survival is considerably higher than the survival in streams. However, there are a number of lakes which need supplemental plants of catchable-size rainbows due to water drawdowns, temperature, growing season; and/or fishing pressure.
   2. Brown trout are even more difficult to catch in lakes than in streams. In lakes where they exist they have been known to grow to large size and create a definite predation problem for the fry and fingerling stocking program.

Chief, Fisheries Mangt. Div., Salt Lake City, Utah.

Hooper, A. D., and Crance, J. H. USE OF ROTENONE IN RESTORING BALANCE TO OVERCROWDED FISH POPULATIONS IN ALABAMA LAKES. Trans. Amer. Fisheries Soc. 89: 351-357. 1960.

Overcrowded sunfish populations have occurred in 5 of Alabama's 18 State-owned public fishing lakes. They have resulted from a combination of factors, including presence of undesirable fish species, infestation with a branched alga, fish kills, loss of fish over the spillway, and heavy fishing. These overcrowded populations were usually balanced by three to seven marginal, or a combination of marginal and sectional, treatments with rotenone applied usually during September and October. The annual average catch by anglers was 193.4 lbs. per acre during the years that the five lakes contained balanced fish populations, and 132.7 lbs. per acre during the years that the lakes contained overcrowded forage fish populations. Although these lakes contained overcrowded forage fish populations for varying periods of time, an annual average of 156 fishermen per acre caught 174.5 lbs. of fish during the 5 to 8 years that the lakes were open to continuous public fishing. The high sustained harvest was attributed to prompt correction of unbalanced fish populations by partial poisoning with rotenone.

The authors concluded that partial poisoning with rotenone is an effective and economical method of restoring balance to bass-bluegill-redear sunfish populations which are overcrowded with intermediate-sized bluegills and redear sunfish. Bullheads and/or crappie augment crowding in bluegill-redear sunfish populations and cause management problems that cannot be readily corrected by partial poisoning.

Ala. Dept. Conserv., Montgomery, Ala.

Buck, D. H., Whitacre, M. A., and Thoits, C. F. III. SOME EXPERIMENTS IN THE BAITING OF CARP. J. Wildlife Mangt. 24: 357-364. 1960.

Experiments were carried out on 225-acre Slocum Lake, 1.4-acre Oxbow Lake, and 4.2-acre Long Lake to test the use of corn for baiting carp, to a small area where they could be enclosed and killed with rotenone. Sour corn seemed to repel most other fishes so that large numbers of carp, and possibly catfishes, could be concentrated and killed with small loss of game fishes. Removal of 93.6 percent (by weight) of the lake's carp population was obtained by one treatment of the baited area in 1.4-acre Oxbow Lake. Results indicated 2 or 3 repetitions might be required in lakes up to 10 acres in size. Control in lakes as large as Slocum (225 acres) would require several treatments in each of several widely separated areas. With continuous baiting, carp can be reconcentrated at fairly short intervals of time. At Slocum Lake, 5,871 lbs. of carp were attracted to the baited area and killed there within 36 to 48 hours following a first treatment with rotenone. The best use of the technique would involve establishment of permanent, continuously baited areas, where carp could be killed as often as they could be concentrated at the bait.

Ill. Natl. Hist. Survey, and Ill. Dept. Conserv., Dundee, Ill.

Lewis, W. M., and Tarrant, R. M., Jr. SODIUM CYANIDE IN FISH MANAGEMENT AND CULTURE. Prog. Fish-Culturist 22: 177-180. 1960.

The results of use of sodium cyanide for fish removal in fish hatcheries and for sampling large lakes and streams are given.

After 2 years of experience with cyanide, the authors are convinced that sodium cyanide has an unusal potential in fish culture, management of small ponds, and sampling of large lakes. It is difficult to imagine any substance's being more suited to the preparation of rearing and brood ponds. Sodium cyanide is easily applied, effective, inexpensive, and under normal conditions would not be expected to have any residual effect beyond the few days required for loss of acute toxicity.

Southern Ill. U., Carbondale, Ill.

Huish, M. T. A SUMMARY OF METHODS USED DURING FLORIDA'S GIZZARD SHAD CONTROL EXPERIMENTS. Proc. Twelfth Annual Conf. Southeastern Assoc. Game and Fish Comn. Oct. 19-22, 1958. pp. 178-183. 1958.

A desirable concentration of 5 percent emulsified rotenone in a given lake to control gizzard shad was found to vary from 0.06 p.p.m. to 0.14 p.p.m. The most favorable results occurred in the fall when good distribution was secured by using six to twelve hours for application, numerous surface units, and dilute mixtures. As many as 4,600 acre feet were treated by one efficiently equipped boat. At least three successive treatments, one year apart, were needed for the most effective control of shad.

Fla. Game and Fresh Fish Comn., Fisheries Expt. Sta., Leesburg, Fla.

Thomaston, W. W., Pierce, P. C., and Wyatt, H. N. EXPERIMENTAL USE OF SILVEX AND OTHER AQUATIC HERBICIDES IN GEORGIA FARM PONDS. Proc. Thirteenth Annual Conf. Southeastern Assoc. Game and Fish Comn. Oct. 25-27, 1959. pp. 101-107. 1959.

The results of two years experimental weed control in Georgia Farm Ponds using silvex, propylene glycol butyl ether ester, dalapon, sodium salt of 2,2-dichloropropionic acid; 2,4-D granules of iso-octyl ester of 2,4-dichlorophenoxy acetic acid. Residual control and overall effectiveness is evaluated over a two-year period on acquatic weeds in approximately 100 ponds. Preliminary screening of Inverton, an invert emulsion of 2,4,5-trichlorophenoxy acetic acid; Garlon, a solution of dalapon and silvex; and simazine, 2-chloro-4, 6 bis-(ethlamino)-S-trizaine are presented.

Different concentrations were used and observations made during 1958 and 1959. Results are presented for different herbicides and evaluation made for their effectiveness on specific aquatic weeds.

Silvex appears to have the widest range of control for underwater and emergent aquatic weeds. Preliminary results indicate this chemical is as effective as sodium arsenite in many situations. Dalapon has given some degree of control for grasses and satisfactory control for cattails. Granular 2,4-D has given satisfactory control for water lilies and parrots feather (Myriophyllum brasiliense). Garlon and Inverton look promising for the control of some aquatic weeds. Simazine has not been generally effective for control or eradication of higher aquatic plants in the concentrations listed.

No address given.

Henderson, C., Pickering, Q. H., and Tarzwell, C. M. RELATIVE TOXICITY OF TEN CHLORINATED HYDROCARBON INSECTICIDES TO FOUR SPECIES OF FISH. Trans. Amer. Fisheries Soc. 88: 23-32. 1959.

Bioassays were conducted on ten commonly used chlorinated hydrocarbon insecticides to determine their comparative toxicity to fish. All of the compounds except BHC were extremely toxic to fish with 96 hour TL_m (median tolerance limit) values generally below 0.1 p.p.m. Endrin was the most toxic with TL_m values ranging as low as 0.6 p.p.b. Bluegills were the most sensitive fish, followed by fathead minnows, goldfish, and guppies, respectively. Changes in water quality characteristics (pH, alkalinity, hardness) had no apparent effect on toxicity. Acetone solutions and emulsible concentrates were equally toxic and were the most toxic formulations. All of the chlorinated hydrocarbon insecticides except BHC were more toxic to fathead minnows than the most toxic of the organic phosphorus insecticides.

Robert A. Taft, Sanitary Engin. Cent., Cincinnati, Ohio.

Eipper, A. W., and Brumsted, H. B. HOW TO CONTROL WEEDS AND ALGAE IN FARM PONDS. Cornell Ext. B. 1014, 24 pp. 1959.

The usefulness and value of a farm pond for any purpose can be greatly reduced by growth of plant life which, in some form, will develop in every pond. This publication describes the types of plants that commonly invade ponds, the problems they may cause, and preventive or control measures.

Tables are presented that give the kind of spray material and the concentration to use for the various types of weed and algae.

Summary of Chemical Treatments.

Algae--Dissolve correct amount of copper sulfate in water and spray over all parts of pond where growth is seen or suspected. Concentrations needed to kill different kinds of algae are: (1) Plankton (water bloom)--$\frac{1}{4}$ p.p.m.; (2) water net--five applications of $\frac{1}{4}$ p.p.m., with one to two days between each; (3) stonewort (muskgrass)--1 p.p.m.; and (4) most filamentous (mat-forming) algae--$\frac{1}{2}$ p.p.m.

Summersed Plants and Filamentous Algae Resistant to Copper Sulfate--Mix correct amount of sodium arsenite solution with water and spray over all parts of pond where weed growth is seen or suspected.

Floating Plants--Mix correct amount of 2,4-D low-volatile ester with fuel oil. Use moderately coarse spray to wet down all exposed leaves. Spray only those areas where floating leaves are present.

Emergent Plants--Mix correct amount of amino triazole (50% active) with water. Use sprayer to wet down all plant parts exposed above water.

Points to Remember--(1) Read all directions carefully; (2) know what type of weed you're working with; (3) know the State laws that apply in your case; (4) use the recommended dosage, treat only when weeds are present, and wait at least two weeks between treatments; and (5) observe precautions given in the bulletin and on the label of the product you buy.

Ext. Serv., Cornell U., N.Y. State Col. Agr., Ithaca, N.Y.

Montgomery, A. B., and Zeller, H. D. THE EVALUATION OF CHEMICAL AQUATIC WEED CONTROL IN GEORGIA FARM PONDS. Proc. Twelfth Annual Conf. Southeastern Assoc. Game and Fish Comn. Oct. 19-22, 1958. pp. 56-63. 1958.

Aquatic weed control has in recent years developed into one of the most important phases of farm pond management in Georgia.

Properly constructed ponds with adequate fertilization which were chemically treated four years ago show no reinfestation at this time. In experimental ponds which were not properly fertilized, the results of chemical weed control were of extremely short duration.

The more frequently used herbicides, Sodium arsenite, 2,4-D (ester and amines), 2,4-D and 2,4,5-T combinations, and Copper sulphate are considered with regard to methods of application, cost of treatments, effectiveness on different plant species, and duration of successful weed elimination.

Sodium arsenite was found universally effective in the control of most submerged aquatic plant species. However, its toxicity to warm blooded animals and the caution necessary in its application and handling restrict its use to experienced technicians. Careless handling of this material in Georgia has resulted in injury to personnel as well as the loss of livestock. Growth regulating 2,4-D and 2,4,5-T compounds were effective in the control of most broad leafed emergent aquatics. The use of both oil and water carriers was evaluated. To achieve complete control, more than one application was usually required. Copper sulphate was found to be the most economical and effective algicide.

Some of the newer aquatic herbicides, Dowpon, Pelletized 2,4-D, Kuron, Novon, and Delrad are discussed in relation to their effectiveness. Particular emphasis was placed on the control of Manna grass (Glyceria sp.) with these chemicals. Those showing promise are further evaluated as to effectiveness on a large variety of plants.

Dowpon appeared very promising in the control of aquatic grasses. Pelletized 2,4-D and Kuron, formulated for use on submerged aquatic species, gave excellent preliminary results. Cost of treatment per acre with these materials is somewhat higher than with sodium arsenite, however, certain advantages offered by these chemicals may offset increase in cost. Delrad was found to be effective in the control of most species of filamentous algae. The use of this material in Georgia was virtually prohibited because of rapid reinfestation following treatment, poor availability, and a high per acre cost of treatment.

Aquatic herbicides were found to be an effective and economical means of eradicating most aquatic nuisances. The advantages and disadvantages of most materials are discussed and the newer herbicides are considered with regard to their use in future aquatic weed control work.

Ga. Game and Fish Comn., Atlanta, Ga.

Johnson, M. C. FOOD-FISH FARMING IN THE MISSISSIPPI DELTA. Prog. Fish-Culturist 21: 154-160. 1959.

Within the last 6 or 8 years, several States in the lower Mississippi River Valley have developed a system of food-fish culture that shows promise of becoming a profitable fishery venture and giving great financial benefits through its effect on conventional agricultural crops. This system involves the rotation of crops of rice with crops of fish. The system has developed almost entirely through trial and error by the rice farmers.

Rice-fish farming is confined almost entirely to parts of Texas, Mississippi, Louisiana, and Arkansas. The discussion is concerned with, and applies mainly to, the rotation of rice and fish crops in Arkansas.

Rice production is a highly mechanized operation. Two or three men are able to cultivate several hundred acres of rice land, and individual fields 200 acres or larger in size are not uncommon.

Delta land that has been cleared recently of trees and brought into rice cultivation is called "new-ground." New-ground is very fertile and with proper management produces about 100 bushels of rice per acre the initial year. Each year thereafter rice production gradually declines; and after the second to fourth year, it is usually so low that the land must be fallowed or planted to some other crop, such as pasture or soybeans, for one or more years before being replanted with rice. Subsequent rotations of rice and other crops follow roughly the same frequency pattern.

The principal fish species produced in the ricefields is the bigmouth buffalo (Megastomatobus cyprinella Val.). The bigmouth buffalo grows rapidly under favorable conditions and reaches a maximum size in excess of 100 lbs. The flesh has a pleasing appearance and good flavor. The buffalo is thought by many to be of poor quality; due mainly to the presence of fine bones suspended in the flesh. However, the bigmouth buffalo is preferred to carp by the American people, and the average wholesale price of the bigmouth is roughly triple that of carp.

Two other species of buffalofish are produced to a lesser extent in ricefields: the smallmouth buffalo (Ictiobus bubalus Raf.) and the black buffalo (Ictiobus niger Raf.). The smallmouth buffalo is generally the best market fish of the three. It has a proportionately smaller head and, therefore, is believed to yield a higher percentage of dressed weight, and it is considered more palatable. However, because of faster individual growth rate and a higher potential in total lbs. that can be produced per unit area, the bigmouth buffalo is preferred by the producer.

The grower engaged in the production of alternating crops of rice and fish may employ three series of impoundments: hatchery ponds, nursery ponds, and finishing reservoirs. The major structural difference in the three types of ponds is one of size. In each type water is impounded by building earthen levees to the desired height in areas of otherwise flat land. The interior of the hatchery ponds and nursery ponds should be graded and smoothed throughout to facilitate the harvest of fish. An interior drainage system consisting of field drains, graded borrow ditches, and, where possible, excavated pits near the outlet, is essential to harvest efficiently the larger finishing reservoirs. Lack of attention to these structural details magnifies the cost of management and harvest.

In summary, the manifold benefits of such a program are: (1) Increased soil fertility and structure; (2) increased rice yields; (3) cash fish crops; (4) recreational value, both financial and esthetic, from hunting and fishing; (5) a long-range increase in human food; and (6) land that, though idle under water, doesn't blow away.

Delta Farm Fisheries, Tillar, Ark.

Brady, L., and Hulsey, A. PROPAGATION OF BUFFALO FISHES. Proc. Thirteenth Annual Conf. Southeastern Assoc. Game and Fish Comn. Oct. 25-27, 1959. pp. 80-90. 1959.

In the Lower Mississippi River Valley the buffalo fishes are highly prized as food, and the wild fishery is of considerable economic importance to the region. In 1957, a total of 5,984,000 lbs. of buffalo were caught, valued at $897,000.00, or an average value to the fishermen of approximately seven cents (7¢) per lb. in the rough. The chronic problem of this wild fishery is the annual cycle of over-supply and saturated markets followed by periods of scarcity.

Down through the years numerous attempts have been made to store the live fish in ponds during the period of oversupply and low prices, with the idea of putting them on the market when the price became more favorable. Most such attempts have proven unsatisfactory because of heavy mortality resulting from injuries received by the fish when they are caught and handled.

Artificial propagation (fish farming) has been offered as a possible solution to maintaining a steady supply of marketable buffalo fish. If fish farming proved to be profitable, it could become a supplemental farm enterprise where suitable soils and waters are available and the topography favorable.

The possibilities of fish farming in the Lower Mississippi River Valley are almost unlimited. Davison (1954) states that all riceland soil is suitable for fish production and gives the following statistics for the year 1952:

Total U. S. A. rice acreage	2,000,000 acres
Southeastern rice acreage	1,200,000 acres
Louisiana rice acreage	510,000 acres
Arkansas rice acreage	480,000 acres
Mississippi rice acreage	52,000 acres

The current over-production of certain basic crops and the resulting acreage controls has caused great interest in fish farming as a possible supplemental crop for the idle fields.

Surface water storage projects for crop irrigation and the construction of scores of "duck reservoirs" in eastern Arkansas have resulted in further interest in the possibilities of artificial propagation of food fishes as a multiple use of these water areas.

Intense interest in commercial fish farming in Arkansas, due to crop acreage controls and other factors, stimulated experiments in buffalo fish propagation at the Joe Hogan State Fish Hatchery, Lonoke, Arkansas.

A pond method of propagation was developed necessitating the use of overwintering or brood ponds, spawning ponds, nursery ponds, and growing ponds.

The culture procedures are set forth in a step by step "cook book" fashion.

Ark. Game and Fish Comn., Lonoke, Ark.

Swingle, H. S. EXPERIMENTS ON GROWING FINGERLING CHANNEL CATFISH TO MARKETABLE SIZE IN PONDS. Proc. Twelfth Annual Conf. Southeastern Assoc. Game and Fish Comn. Oct. 19-22, 1958. pp. 63-72. 1958.

Gill flukes and other external parasites were controlled on fingerling channel catfish by treatment with 4 p.p.m. potassium permanganate for 1 hour and with 15 p.p.m. formalin for 5 to 10 hours. Tapeworms and other intestinal parasites were controlled by use of feed containing 0.3 percent di-n-butyl tin oxide. The medicated feed was fed at 3 percent of the body weight of the fish each day for 3 days. Spread of disease during transportation and handling was reduced by holding the fish in 1 p.p.m. acriflavine.

It was suggested that feed conversion values where supplemental feeding is practiced in ponds be designated by the letter S, where:

$$S = \frac{\text{Pounds feed supplied}}{\text{Total pounds of the stocked fish produced in the pond}}$$

with no correction applied for the lbs. of fish that might have been produced without feeding, and no correction for the presence of wild fish. The C conversion, then would be used only where natural feeds and competing species were absent or proper corrections had been made in the production figures for their presence.

Dry mixed feeds, designated as Auburn No. 1 and No. 2 fish feeds were used. Pelleting the dry feed resulted in more efficient usage, gave higher production, and resulted in less pollution of the water.

A tentative sliding scale of rates of feeding for production ponds was developed based on the estimated pounds of catfish present. Estimates were made monthly from seining samples and the rates of feeding readjusted when necessary.

Feeding was discontinued in the production ponds when water temperatures fell below 60°F. The main growing period for channel catfish was during the period when water temperatures remained above 70°F.

Fingerling channel catfish stocked in the spring grew to marketable size in an average of 228 days and gave an average S conversion of 1.87. Fall-stocked fingerlings required an average of 394 days to grow to marketable size, with an average S conversion of 3.0.

Rates of stocking were varied from 1,000 to 5,000 fingerling catfish per acre. The gain in lbs. per acre per day and the total production per acre increased with increasing rates of stocking, while average size of the catfish at harvest decreased. The maximum production of 2,343 lbs. per acre in a 252-day experiment was obtained from a stocking of 2,000 fingerlings. The maximum production of 2,003 lbs. catfish per acre in a 188-day experiment was obtained with a stocking rate of 5,000 fingerlings.

The presence of wild fish decreased the production of channel catfish and resulted in high S conversion values, with correspondingly increased costs per lb. of catfish produced.

Loss on dressing catfish harvested in the spring was from 43 to 45 percent, and the loss on fall-harvested fish was from 39.5 to 41 percent. Labor costs of dressing and packing, at 50 cents per hour for labor, averaged 2.16 cents per fish. Where sold at 55 cents per lb. of packaged fish, and subtracting the cost of feed, fertilization, and the labor of dressing and packing, the return for spring-stocked fish was $266.40 per acre for capital and other costs of production. These other costs includes the costs of the fingerling fish required for stocking. Fall stocking yielded a comparable $240.00 per acre.

Agr. Expt. Sta., Ala. Polytech. Inst., Auburn, Ala.

Kimsey, J. B., and Fisk, L. O. KEYS TO THE FRESHWATER AND ANADROMOUS FISHES OF CALIFORNIA. Calif. Fish and Game 46: 453-479. 1960.

The need for keys to all the freshwater and anadromous fishes of California long has been apparent to both scientific workers and laymen. Although numerous keys to California fishes have been published, they have been either restricted to certain drainages or to groups of fishes.

The keys are designed to aid people in knowing what California freshwater or euryhaline fish they have in hand. There is no intention to satisfy the needs of the professional taxonomist. Microscopic examination or complicated statistical comparison is unnecessary. The use of internal key characters has been limited to pharyngeal teeth and pyloric caeca counts. A hand lens will be useful.

Calif. Dept. Fish and Game, Sacramento, Calif.

Alabama Department of Conservation. BIOLOGISTS REPORT ON A PROJECT--FROM FISHERIES RESEARCH COMES . . . PUBLIC FISHING APLENTY. Ala. Conserv. 31(8): 21, 23. 1960.

Alabama Department of Conservation fishery biologists scored a multiple victory recently in scientific pond management at the reopening of Buck and Ditch Ponds in the Conecuh National Forest.

An estimated 300 fishermen swarmed the tiny 10-acre lakes, recording a combined day's catch of over 500 pounds of the new exotic tilapia.

The experimental fish is currently being used by the Fishery Section of the Game and Fish Division to determine its effectiveness in controlling obnoxious algae, and as a test measure to learn its value as a game fish.

Biologists for the past two years have added tilapia to at least 11 of the state's owned and managed fishing lakes in the scientific study to determine its fighting characteristics and its effectiveness in controlling algae. The tilapia are being used only on an experimental basis, and are not available for general stocking.

Biologists said although aquatic growth in both ponds had cleared considerably, the extent to which the tilapia aided in this retardation would depend on results of tests to be conducted throughout the remainder of the summer.

No address given.

Upland Wildlife

Weaver, R. A., Vernoy, F., and Craig, B. GAME WATER DEVELOPMENT ON THE DESERT. Calif. Fish and Game 45: 333-341. 1959.

Water or the lack of it, is a major controlling factor on game populations in arid areas. In comparatively well watered areas there are often dry localities where water development will enable game concentrations to spread out, and thus increase the carrying capacity of the range.

Spring development is not a complicated procedure. It consists mostly of hard manual labor in making water available to game, or of concentrating and conserving a small water supply. Most springs may be grouped as either good and not needing development, or as wet-weather springs that dry up and can't be improved because they are not permanent. The good springs, unless remote, are usually appropriated by local residents. So it is the marginal spring that is generally improved and developed for game.

This article describes construction and use of various ways of developing water areas in the desert.

Calif. Dept. Fish and Game, Sacramento, Calif.

Trumbo, H. A., and Chappell, W. E. TECHNIQUES INVOLVED IN THE USE OF CHEMICALS FOR ESTABLISHING WILDLIFE CLEARINGS. Proc. Thirteenth Annual Conf. Southeastern Assoc. Game and Fish Comn. Oct. 25-27, 1959. pp. 34-38. 1959.

Wildlife clearings and/or food patches are essential management tools for a number of game bird and animal species. Such areas are valuable from several standpoints: attractiveness, as an open area or "playground," to provide more "edge" or shrubby growth, and those planted to agricultural crops as a source of supplementary foods.

Bulldozing and hand labor are the formost methods of establishing and maintaining such wildlife clearings. Although these methods have been quite successful, they are also costly; the two main categories of cost are labor and equipment, with a number of factors contributing to each one.

It is apparent that fenuron and monuron are the most effective herbicides for killing a greater proportion of the tree species; fenuron being more desirable because quicker results are obtained. Both of these herbicides can be easily transported into inaccessible areas in knap sacks and no other equipment is necessary. Areas treated with these chemicals could be left until the stems have partially decayed, then remove them or leave undisturbed for their value as an open area. A considerable number of annual and perennial plants invaded these areas during the first growing season after treatment. Oak and sassafras seedlings were present in limited numbers.

Due to the great number of sprouts produced by the the use of Ammate, this method of treatment might be used to produce browse in areas where it is desired, but because the original stems must be frilled and treated or cut and stump treated (not carried out in this experiment) and equipment necessary, Ammate would probably be used on a limited scale.

The use of 2,4,5-T in spaced ax-cut frills is not a satisfactory method of creating an opening such as might be used for a wildlife clearing or removing undesirable tree species. Perhaps a frill consisting of overlapping ax cuts would be more effective.

Herbicides as a wildlife management tool shows great promise for creating wildlife clearings and controlling undesirable tree and shrub species. It is improbable that they will replace bulldozing as a method of creating clearings; what is to be accomplished and accessibility of areas will be the determining factors.

TABLE.--Cost Comparison Per Acre of the Four Herbicides Used on the Broad River Project

	Ammate	2,4,5-T	Fenuron[1]	Monuron[2]	Bulldozing
Labor	$17.70	$17.10	$11.50	$ --	$ --
Chemical	22.50	9.66	95.00	--	--
Oil	--	--	--	--	--
Dozer and Operator	--	--	--	--	[3]90.00
Totals	$40.20	$36.54	$106.50	$ --	$90.00

[1] Based on 5-10 active per stem.
[2] Cost not available.
[3] Does not include time spent by resident game manager on hand clean-up work necessary to condition areas for tilling.

Va. Polytech. Inst., Blacksburg, Va.

Anderson, W. L. MAKING LAND PRODUCE USEFUL WILDLIFE. U.S. Dept. Agr. Farm. B. 2035, 29 pp. 1960.

Many of the practices used on farms and ranches help wildlife, others are harmful. Some of these many practices are summarized by different kinds of land use as follows:

1. Cropland practices helpful to wildlife are: (1) Cropping systems that include grass-legume meadows; (2) liming and fertilizing; (3) stripcropping; (4) cover crops; (5) stubble-mulch tillage; (6) delaying mowing of headlands, roadsides, and watercourses until after the nesting season; and (7) leaving unharvested 1/8 to 1/4 acre of grain next to good cover.
2. Cropland practices harmful to wildlife include clean fall plowing; mowing of watercourses and headlands before ground-nesting birds have hatched; and burning of ditchbanks, fence rows, and crop residues.
3. Pastureland practices helpful to wildlife are: (1) Grazing within the carrying capacity of the pasture; (2) liming and fertilizing; (3) reseeding, renovating, or overseeding with legumes; and (4) building ponds for livestock water.
4. Pastureland practices harmful to wildlife are uncontrolled burning, overgrazing, and complete clean mowing early in the season.
5. Rangeland practices helpful to wildlife include: (1) Proper grazing and salting; (2) watering places for livestock; (3) reseeding; (4) construction of walkways in marshy range; and (5) partial brush removal.
6. Rangeland practices harmful to wildlife are overgrazing and complete brush removal.
7. Woodland practices helpful to wildlife include: (1) Protection from unwanted fire and harmful grazing; (2) selective cutting in small woodlands; (3) leaving den trees when cutting hardwood timber; (4) piling brush near the edge of the woods; (5) "release" cuttings to increase production of acorns, nuts, and other tree seeds useful for wildlife food; (6) cutting trees out of woodland borders to increase the growth of shrubs for food and cover; (7) clear-cutting when harvesting aspen and western conifers; and (8) seeding clovers and grasses along roads and trails and in woodland openings.
8. Woodland practices harmful to wildlife are uncontrolled burning and grazing and cutting of all den trees.

Wildlife land includes any land managed especially to produce desired kinds of fish and wildlife. Many of the helpful practices listed above under other land uses are also applicable to wildlife land.

Special practices include: (1) Controlled burning; (2) food-patch planting; (3) mowing or using herbicides to keep woody plants out of areas that should stay in low-growing grasses, legumes, and other herbaceous plants; (4) seeding grasses and legumes; (5) planting trees and shrubs, especially in prairie areas; and (6) managing water--this includes construction of earth fills, installation of water-level control structures, and, in the arid parts of the country, establishing wildlife watering places.

Eight kinds of areas on farms and ranches that can be managed especially for wildlife are: (1) Wetlands; (2) ditchbanks; (3) odd areas; (4) ponds; (5) fence rows and hedge rows; (6) wildlife borders; (7) windbreaks; and (8) streambanks.

This bulletin gives recommendations for wildlife management for all eight areas.

ARS, USDA, Inform. Div., Washington 25, D. C.

Baskett, T. S., Dunkeson, R. L., and Martin, S. C. TEN-YEAR TIMBER-CUTTING CYCLE PROVIDES A CONTINUING SUPPLY OF FORAGE. Central States Forest Expt. Sta. Note 125, 2 pp. 1958.

Harvesting merchantable trees and killing culls in Missouri forests produce small openings in which deer and cattle forage is increased. The value of this forage increase depends in part on whether it lasts until the next cutting. To determine the duration of such forage increases, vegetation was measured on 1-square foot plots around stumps of large trees in a typical white oak stand in the southern Ozarks 3, 6, and 9 years after a timber sale, and compared with vegetation around uncut trees of similar size. Openings around stumps were still visible after 9 years, but growth of the crowns of saplings and surrounding large trees had decreased their size.

By 1950, three years after the cut was made, all low-growing vegetation except tree reproduction had increased strikingly as compared with vegetation on similar uncut areas. During the next 3 years, forbs and grasses declined in frequency (a measure of abundance), tree reproduction remained steady, and browse continued to increase on both released and unreleased areas. During the last 3 years, forbs, grasses, and browse decreased, but tree reproduction increased. Whereas grasses and forbs dominated the understory vegetation in 1950, tree reproduction and browse were dominant in 1956.

Although the greatest forage production in these new openings in forest stands occurred within the first 3 to 6 years after cutting, significant benefits lasted 9 years. Thus, under the conditions sampled, the 10-year cutting cycle used on managed forests in Missouri Ozarks creates new openings while the older ones are still productive and provides a continuing supply of forage, particularly for deer.

Central State Forest Expt. Sta., FS, USDA, Columbus, Ohio.

Buchholtz, K. P., and Bayer, D. E. ESTABLISHMENT OF WILDLIFE FOOD PATCHES IN SOD WITHOUT TILLAGE. J. Wildlife. Mangt. 24: 412-418. 1960.

Satisfactory yields of corn were produced on sodded areas without tillage after applications of simazine or combinations of dalapon and simazine. Applications of dalapon and amitrol, alone or in combination, were less satisfactory for control of perennial grasses, and control of annual weeds was also poor. Applications of simazine were most effective when made in early spring. Dalapon or a combination treatment containing dalapon must be applied at least 4 weeks prior to corn planting in order to avoid injury to the corn. Use of a complete fertilizer increased yields of corn appreciably in one study but did not result in more economical production of corn. Cost for chemicals and fertilizer when using the more satisfactory treatments averaged about $1.00 per bushel, and in one instance was as low as $0.54 a bushel. Use of herbicides in the manner described will allow production of corn in remote areas for wildlife purposes, without the use of heavy mechanical equipment, and without attention after the planting has been completed.

U. Wisc., Madison, Wisc.

Korschgen, L. J. PRODUCTION OF GAME BIRD FOODS IN MISSOURI. J. Wildlife Mangt. 24: 395-401. 1960.

The amount of food available on certain types of landscape in autumn to upland game, particularly quail, doves, and pheasants was studied. Previous food habits analyses of numerous samples have shown the kinds and quantities of foods eaten by Missouri's game birds. Information was needed to show whether the principal foods were normally available in quantities adequate for current or increased populations. The present investigation covered an extensive area, so that general averages of the most important foods could be obtained.

The 632 topsoil ground samples collected from 6 areas of Missouri during 1954 and 1955 were analyzed to learn the amount of food available to upland game birds in autumn. Eight field types were sampled. Seeds were classified as select and nonselect on the basis of use by game birds. Select foods averaged 102 lb. and nonselect foods 37 lb. per acre in northern Missouri; 55 lb. select and 52 lb. nonselect seeds per acre were found in southern Missouri. Moderate to severe drought seriously affected the amount of seed produced. Cornfields, pastures, and soybeans fields were the heaviest producers of game bird foods in northern Missouri, while pastures, fallow-waste areas, and small grain fields produced greatest amounts in southern Missouri. Production of select foods generally exceeded that of nonselect foods, indicating that certain items are select because of availability, although availability alone does not explain food habits of game species.

Mo. Conserv. Comn., Columbia, Mo.

Goodrum, P. D. ACORNS IN THE DIET OF WILDLIFE. Proc. Thirteenth Annual Conf. Southeastern Assoc. Game and Fish Comn. Oct. 25-27, 1959. pp. 54-61. 1959.

Oak mast is one of the most important wildlife foods in the South. It ranks high in nutritive content as well as volume and frequently of consumption, and it is available for long periods. Being high in carbohydrates and fats, it is one of the best foods on which game can fatten and thus condition themselves for the lean winter months.

To determine the value of acorns in basic wildlife rations or diets, it is necessary to know the moisture content. This information is presented for several oak species.

Acorns are available in significant quantity to most southern game species for six months of the year. Based on currently available data on food requirements and average yearly acorn yields for several oaks, five game species need about 57 and 34 lbs. of acorns, fresh and air-dry, respectively, to satisfy their requirements for 180 days.

This poundage may be provided by an average of four 18-inch water oaks or eight 22-inch postoaks per acre. The number and size of trees needed will depend upon what is available as to size and species. The presence of several species will lessen the chance of a complete crop failure.

The larger oaks are the best mast producers, and if these are removed it may take from 20 to 75 years to replace them.

U.S. Bur. Sport Fisheries and Wildlife, Nacogdoches, Tex.

Murray, R. W. THE EFFECT OF FOOD PLANTINGS, CLIMATIC CONDITIONS, AND LAND USE PRACTICES UPON THE QUAIL POPULATION ON AN EXPERIMENTAL AREA IN NORTHWEST FLORIDA. Proc. Twelfth Annual Conf. Southeastern Assoc. Game and Fish Comn. Oct. 19-22, 1958. pp. 269-274. 1958.

When land in northwest Florida is taken out of corn and peanut production and converted into grazing land, the carrying capacity of that land for quail is seriously lowered. The reason for this decline is that some of the leading foods in this section of the State are destroyed in this land use conversion. Not only are such important foods as corn and peanuts lost, but other annuals such as Florida beggarweed, watergrass, and ragweed are lost. Grazing, especially overgrazing, destroys natural foods and much protective ground and escape cover. This study shows that something is lost on agricultural quail range in this section of the State, when it is taken out of corn and peanut production, that cannot be duplicated through food planting programs. This is a disturbing thought when it is realized that we are face to face with the Soil Bank Program.

Fla. Game and Fresh Water Fish Comn., Tallahassee, Fla.

Scott, D. F. FIRE AND QUAIL MANAGEMENT AT FORT CAMPBELL, KENTUCKY. Proc. Twelfth Annual Conf. Southeastern Assoc. Game and Fish Comn. Oct. 19-22, 1958. pp. 294-300. 1958.

In a study of fire and quail management at Fort Campbell, Kentucky, the authors concluded that:

1. Prescribed burning is a practical and economical quail management tool. This technique is applicable with certain modifications to areas other than the southern coastal plain.
2. Number of quail harvested per thousand acres on a prescribed burned area was considerably higher than the harvest on a similar unburned area.
3. Hunting pressure increased considerably on a burned area one year after burning while it remained constant on a similar unburned area.
4. Hunter success increased on a burned area one year after burning, while the success in a similar unburned area remained almost the same.
5. Prescribed burning as described in this paper did not materially hamper quail hunters. Burning may be carried out during the hunting season without seriously affecting hunting success.
6. Food and cover conditions have been corrected to some extent by the use of prescribed burning. Burning has increased hunter success. This technique is maintaining food and cover conditions extremely favorable to quail on approximately 80,000 acres of land.
7. It is believed that an annual quail harvest of 20,000 birds or more can be maintained at Fort Campbell if burning operations are continued. Approximately 80,000 acres are open for hunting at Fort Campbell.
8. The use of fire as a silvicultural and game management tool must be handled by the forester and the game biologist so as to insure maximum beneficial results instead of disastrous results.

Post Engin. Forester, Office of the Post Engin., Fort Campbell, Ky.

Floyd, J. FACTS ABOUT FLORIDA QUAIL. Florida Wildlife 14(6): 13-15, 38. 1960.

An illustrated, informative question and answer article on Florida Quail Management.

Inform.-Educ. Div., Fla. Game and Fresh Water Fish Comn., Tallahassee, Fla.

Hall, J. G. WILLOW AND ASPEN IN THE ECOLOGY OF BEAVER ON SAGEHEN CREEK, CALIFORNIA. Ecology 41: 484-494. 1960.

Two pairs of beaver were introduced on Sagehen Creek in 1945. Ten years later the number had increased to about 30 animals distributed in 5 colonies along the stream. Three of the colonies were studied for several seasons in order to explore the interaction between beaver and their 2 chief food-and-building resources, willow and aspen.

The rate at which beaver cut aspen was found to be correlated directly with the supply. On the other hand, rate of willow use showed no correlation with willow supply but was related inversely to aspen supply. These relationships are interpreted to mean that aspen is the first choice item; as it is used up the beaver take more and more willow.

According to an analysis at the colony where aspen was most abundant, the principal factor influencing a beaver's choice of size of tree to cut is the relative numerical availability of the sizes in the stand. A slight but significant preference for trees of the 2-inch diameter class was demonstrated. This preference is thought to be due primarily to superiority of 2-inch trees as a building material rather than as a food source.

The exceptional sprouting vigor of willow makes it much more tolerant of the inroads of beaver activities than is aspen. Even so, beaver have a tendency to overbrowse within the immediate colony area. The result is that sprouting vigor gradually declines and rate of growth falls behind rate of harvest.

Use of aspen never is on a sustained yield basis. When beaver have consumed the aspen in one locality, it is gone. Willow resprouts much more successfully than aspen, but the beaver still tend to eat it more rapidly than it grows.

However, as one site becomes exhausted of willow, the beavers shift gradually up or downstream to better stands, thus permitting the original area to recuperate. Consequently, in terms of the entire stream, the willow is on a sustained use basis in a manner analogous to block-cutting as practiced by foresters.

Museum of Vertebrate Zoology, Berkeley, Calif.

Adams, W. H., Jr. CHOCCOLOCCO DEER RANGE ANALYSIS AND MANAGEMENT IMPLICATIONS. Proc. Thirteenth Annual Conf. Southeastern Assoc. Game and Fish Comn. Oct. 25-27, 1959. pp. 21-34. 1939.

In retrospect, the Choccolocco deer range has undergone the following sequence of events: (1) Extermination of native deer; (2) restocking; (3) complete control via closed seasons and law enforcement; (4) hunting under a buck law restricted to the removal of branch-antlered-deer only; and (5) improved harvest by permitting the removal of male deer with visible antlers without regard to branching. Despite this sequence of events and management practices, the annual rate of increase has always exceeded the harvest. Failure to remove these surplus deer has subsequently resulted in heavy utilization of food plants and a reduction in numbers and coverage of more palatable food plants. This condition is especially manifest during the "critical period" in late March and early April.

In support of this conclusion, the Choccolocco range surveys clearly indicated that the trend is towards rapid deterioration as suitable deer habitat. Honeysuckle, hydrangea, mountain laurel, sweetleaf, and red cedar displayed distinct browse lines in many localities. Reproduction was severely hampered or prevented entirely on strawberry-bush and yellow-poplar in many stream bottom sites. Also indicative of this trend was the initial and limited utilization of generally regarded low quality food plants such as pine and alder.

This method of range appraisal can be applied to other areas in the Southeast because: (1) It provides a rapid evaluation of prevailing range condition in time to invoke remedial action; (2) it can serve as a basis for deer management without regard to the difficult question of exactly how many deer are on a particular range; (3) it can be readily consolidated with the current rate of reproduction obtained from checking station data (assuming either sex hunting); and (4) on newly stocked areas, it can be permanently established (in conjunction with the erection of adequate exclosures) as a standard to compare with similar ranges in various stages of occupancy and condition.

This method of range appraisal is especially valuable since our knowledge of deep population and range interrelationships is still too meager to permit hard-fast and unwavering management conclusions. It is now more practical to manage deer on a trend-concept basis. This concept is proposed as a replacement for the oft-encountered supposition that deer can be properly managed only by knowing every facet of their life history. Complete knowledge will require many years of basic research and may remain an ideal never attained. Until this gap in knowledge is narrowed, trend-concept management is recommended for present-day management of deer in the Southeast.

In order to prevent crowding and range deterioration, the management of any deer range should be based on its hunting capacity, i.e., the known minimum number of deer that will definitely be removed by hunting during any particular season. This can be accomplished by initiating hunting within an expanding deer population early enough so the annual rate of increase will not exceed the hunting capacity. On long-established and overbrowsed areas, extended seasons and either sex hunting should remove excess deer. Once this is accomplished, hunting regulations can be modified as hunting pressure increases or decreases. A safety factor should be allowed to operate between carrying and hunting capacities.

The number of deer left after hunting may be referred to as the residual population. It is comprised of all age groups including the previous summer's fawn crop. Under ideal management conditions, hunting will remove annual deer surpluses in excess of the carrying capacity so the residual population will not exceed the maximum number of deer that may be consistently and safely carried overwinter with minimal deer mortality and damage to the range. Good management practices can be applied to residual populations above or below the carrying capacity in order to bring them under proper control.

Tenn. Game and Fish Comn., Madison, Tenn.

Blair, R. M. DEER FORAGE INCREASED BY THINNINGS IN A LOUISIANA LOBLOLLY PINE PLANTATION. J. Wildlife Mangt. 24: 401-405. 1960.

A loblolly pine plantation in central Louisiana was thinned at age 20 and again at age 25 to residual basal areas of approximately 100, 85, and 70 square feet of pine per acre.

By age 29, stands were generally two-storied, with hardwoods beneath the dominant pines. Stocking of hardwoods was in direct relation to thinning intensity and correspondingly limited the growth of understory vegetation suitable for deer forage. The combined yields of browse, grasses, grasslike plants, and forbs varied from 215 lbs. per acre under light thinning to 299 lbs. under heavy thinning. Browse palatable to deer ranged from 90 lbs. per acre under light thinning to 137 lbs. under heavy thinning. Yields of nonpalatable browse were similar under all intensities of thinning. Palatable browse available during the winter averaged 63 percent of the summer's production.

Southern Forest Expt. Sta., FS, USDA, New Orleans, La.

Holmgren, R. C., and Basile, J. V. IMPROVING SOUTHERN IDAHO DEER WINTER RANGES BY ARTIFICIAL REVEGETATION. Idaho Dept. Fish and Game Wildlife B. 3, 61 pp. 1959.

Artificial revegetation has been considered a practicable means of improving western rangelands since the early years of this century. Current appreciation of the principles involved stems largely from intensive and extensive investigations started in the middle 1930's by various Federal and State agencies and colleges. These studies dealt mainly with improvement of forage for livestock and of vegetal cover for soil protection, but contributed little to general knowledge of browse revegetation.

Recognizing the need for increased browse production on some depleted big-game winter ranges, the Idaho Fish and Game Department and the Intermountain Forest and Range Experiment Station in 1949 started a program of research on aspects of revegetation more or less peculiar to these problem areas. This bulletin summarizes the results of the cooperative studies. It recommends tested techniques for game range revegetation based on these and other research findings.

FS, USDA, and Idaho Dept. Fish and Game, Boise, Idaho.

Reynolds, T. A., Jr. THE MULE DEER. Utah State Dept. Fish and Game, Dept. Inform. B. 60-4, 32 pp. 1960.

A report on the history, life history, and management of the Mule Deer in Utah.

Utah State Dept. Fish and Game, Salt Lake City, Utah.

Wetland Wildlife

Wright, T. W. WINTER FOODS OF MALLARDS IN ARKANSAS. Proc. Thirteenth Annual Conf. Southeastern Assoc. Game and Fish Comn. Oct. 25-27, 1959. pp. 291-296. 1959.

A total of 583 mallard gullets was examined during the 1957-58 and 1958-59 hunting seasons to determine the foods of the mallard in central Arkansas. The area studied is one of the major rice-growing and duck-wintering areas in the United States.

Weather conditions affected the food percentages. Ducks ate acorns more during the wet year, 1957, when all bottomlands were flooded by heavy rains.

A summary of land management for ducks is given including rice fields, woodland, and special planted duckfields. Experience with special duckfields planted to browntopmillet is included. The browntopmillet proved to be a choice food of mallards when managed properly. Experience with other duckfields including corn, soybeans, and grain sorghums is also given.

The study indicates the importance of rice and associated plants in feeding mallards. Rice and grass seeds associated with rice culture accounted for 65.9 percent of the foods eaten.

Acorns, barnyardgrass, browntopmillet, Japanesemillet, junglerice, paspalum (bull), rice, and soybeans are choice winter foods of mallards in Arkansas. Though this study does not prove it, corn, marshpepper and swamp smartweeds, and grain sorghum are known to be choice foods. No definite conclusions can be drawn to rate the quality and acceptance of the following foods which were found in minor amounts: beggarticks, flatsedge (seeds and tubers), lespedeza (annual), plantain (mud), signalgrass, witchgrass, sumpweed, canarygrass, beakrush, paspalum (longtom), spikesedge, smartweed (Pennsylvania and curltop), and ragweed. Blackgum, dogwood, hawthorn, rose, and applejack are shown to be unimportant, indigestible foods by comparison of the contents in matched gullets and gizzards.

SCS, USDA, Lonoke, Ark.

Kadlec, J. A. THE EFFECT OF A DRAWDOWN ON THE ECOLOGY OF A WATERFOWL IMPOUNDMENT. Mich. Dept. Conserv. Game Div. Rpt. 2276, 181 pp. 1960.

A study to determine the ecological effects of a drawdown on a waterfowl impoundment was conducted on the Backus Lake flooding project in the north central part of the Lower Peninsula of Michigan. The investigation was designed to consist of the following three phases: (1) During the summers of 1956 and 1957, the predrawdown conditions were assessed; (2) the water level was lowered about four feet during the summer of 1958 and the results observed; and (3) the area was reflooded and the post-drawdown conditions studied in 1959.

The investigation included studies of the soil, water, vegetation, invertebrates, and waterfowl. For purposes of comparison, limited studies of a similar nature were conducted on other nearby waterfowl impoundments.

The results of soil and water studies indicated a definite increase in plant nutrients in the water as a result of the drawdown. Also, a marked increase in soil nitrates occurred during the drawdown as a result of aerobic nitrification. The effect persisted at least until the spring of the first year of reflooding. The response of other nutrients was less definite, but increased solubility was noted and plant growth improved. It was found that the best results were obtained when the organic portion of the soil remained moist or even very wet during the drawdown.

Organic decay may result in nutrient release in two principal ways: (1) Nutrients in organic compounds may be mineralized to an available form; and (2) ions held by colloidal organic material may be released as the material decays.

Invertebrate populations, a potential food supply for waterfowl, were found to be considerably reduced after reflooding.

The species composition of the vegetation was not notably affected by the drawdown. Most of the common species prior to the drawdown were perennials and apparently able to survive drainage for one growing season. Many of the submerged and floating-leaf plants were reduced in abundance during the first year of reflooding, however. The exceptions were waterlilies, water smartweed, and bushy pondweed.

Emergent species, in general, spread and increased in abundance as a result of the drawdown. Many of these plants require an exposed soil for a seedbed and for early growth and respond rapidly to the occurrence of such a situation provided by a drawdown. Sorting of species becoming established in this way was observed. Sedges and woolgrass were most abundant on portions of the study area which became very dry. Cattail, bulrush, and burreed were more abundant in areas where considerable moisture was retained in the soil throughout the drawdown. Rice cutgrass and mannagrasses were more generally distributed. There was very little mortality among emergent plants during the first year of reflooding.

Wetland food production during the drawdown was disappointing. Poor growth of millet and smartweed was probably due to the absence of an adequate seed supply and to excessive drying of the bottom soil. Rice cutgrass was abundant, but did not produce much seed.

Utilization of the area by waterfowl increased in the late summer of 1959. The abundance of food, principally bushy pondweed, was very attractive to ducks. Populations of breeding waterfowl did not change appreciably throughout the study. Observations on other areas indicated that brood production is closely associated with emergent cover which persists through the winter. The cover developed by the 1958 drawdown in Backus Lake was submerged by reflooding and was not available in early spring. Use by breeding waterfowl should increase in 1960, however.

Properly used, the drawdown can be an effective marsh management technique. Cover can be improved, aquatic food production increased, interspersion improved, and a variety of wetland foods produced.

The use of the technique must be on an individual basis. The drawdown is not a panacea for all marsh management problems. A wide variety of other techniques, such as burning, herbicides, and level ditching, are available and have important uses. Some of them are admirably suited for use in conjunction with a drawdown.

Mich. Dept. Conserv., Game Div., Lansing, Mich.

Naylor, A. E. THE WOOD DUCK IN CALIFORNIA WITH SPECIAL REFERENCE TO THE USE OF NEST BOXES. Calif. Fish and Game 46: 241-269. 1960.

Information is presented on the early history and abundance of the wood duck in California. Destruction of habitat and overshooting caused the early decline in numbers of wood ducks. Hunting restrictions have resulted in a partial recovery of the species.

The summer range extends over much of California north of the Tehachapi Mountains. The breeding population was estimated at 1,500 pairs. California is the major wintering area for wood ducks on the Pacific Coast. Central California furnishes habitat for most of the estimated wintering population of about 55,400 wood ducks.

A five-year study, 1952-56, was conducted to determine the feasibility of a nest box program.

A total of 152 boxes was installed and 42 percent were used annually by wood ducks.

Seventy-six percent of the nests hatched successfully. The average clutch size of successful nests was 13.3 eggs. Dump nests averaged 28.5 eggs per nest.

Desertion was recorded in 16 percent of the nests; destruction occurred in eight percent of the nests.

A total of 119 boxes ('31 percent) was occupied by species other than wood ducks. Sparrow hawks, honey bees, and screech owls were most commonly found using the boxes.

An average of 11 percent of the boxes was found to be nonfunctional each year.

Adequate maintenance must be included in any program of nesting box installation.

Calif. Fish and Game, Sacramento, Calif.

Anderson, W. STUDY OF WATERFOWL NESTING IN THE SUISUN MARSHES. Calif. Fish and Game 46: 217-226. 1960.

The Suisun Marshes, an area comprising approximately 140 square miles in Solano County, California, was the locale of a duck nesting study conducted from late April to July 1, 1959.

To all appearances, large sections of the Suisun Marshes possess the requirements essential to waterfowl production, being favored with a sufficiency of food, nesting cover, and water. However, it has been long apparent to investigators that duck nesting in this area falls far below expectations.

The objectives of the present investigation were to evaluate production as compared with that of 1953, and to determine any factors tending to discourage a normal nesting population.

The Suisun Marshes consist largely of an intricate system of sloughs and channels separating land areas. Some of these land areas are so dry during the spring and summer months that they are of little value as duck nesting habitat. The State Waterfowl Management Areas, Grizzly Island and Joice Island, comprise somewhat over 10,000 acres. A substantial portion of Grizzly Island is planted to waterfowl food crops, mainly barley. The remainder of the Siusun area is for the most part occupied by gun clubs and devoted to waterfowl shooting during the open season. The marsh supports a relatively high wintering population of birds, and the hunting success has compared favorably with that of other California wetlands.

This study showed that: (1) Only 63 duck nests were located, 27 of which were mallard, 33 cinnamon teal, and three gadwall. No coots were found to be nesting in the area. (2) Mallards nests were scattered thinly throughout the area. Cinnamon teal showed a preference for nest sites in saltgrass within a few yards of water. (3) Of the 63 nests included in the sample, 44.4 percent hatched successfully, 36.5 percent were destroyed, and 19.1 percent were deserted. (4) Hatching success in this study approximated that shown in a study made in 1953. (5) Brood observations indicated that there was a poor rate of survival among young ducks. (6) Fluctuating water levels, extensive stands of tules and cattails, and cracks in peat soils are listed along with predation as incompatible to satisfactory nesting conditions. And (7) an experiment with predator control on one or more islands is suggested.

Calif. Dept. Fish and Game, Sacramento, Calif.

Rienecker, W. C., and Anderson, W. A WATERFOWL NESTING STUDY ON TULE LAKE AND LOWER KLAMATH NATIONAL WILDLIFE REFUGES, 1957. Calif. Fish and Game 46: 481-506. 1960.

A study was made of nesting Canada geese, ducks, and coots on Tule Lake and Lower Klamath Refuges during the waterfowl nesting season of 1957. The authors made the following conclusions:

1. A total of 267 goose nests, 1,151 duck nests, and 94 coot nests were located and studied.
2. The hatching success of Canada geese was 78.7 percent, with 12.7 percent of the nests deserted, 7.1 percent destroyed, and 1.5 percent flooded. The average clutch was 5.5 eggs. The average number of eggs hatched was 4.8. The nesting period for Canada geese lasted approximately 79 days, with the peak of hatch during the period from April 22 to May 2.
3. The hatching success of all ducks was found to be 84.8 percent. Shovelers had the highest success with 94 percent and ruddy ducks the lowest with 69.2 percent. The principal causes of nest failure among the ducks were desertion 7.8 percent and predation 6.6 percent. In successfully hatched nests 98.7 percent of the eggs hatched, 6.4 percent contained dead embryos, 2.2 percent were infertile, 1.3 percent were missing, and 0.2 percent hatched but the young were found dead in the nest. The first nest hatched during the period April 22 to May 2 and the last nest to hatch of those studied, hatched during the period August 2 to 12. The peak of hatch occurred between June 12 and 22. The average clutch was 9.6 eggs. The average hatch per clutch was 8.6 ducklings which were reduced to 7.6 ducklings per brood during the first week of life.
4. Ninety-four coot nests were located of which 93 percent hatched and seven percent were flooded. In the successfully hatched nests 99.2 percent of the eggs hatched, 0.4 percent contained dead embryos and 0.4 percent were missing. The average clutch consisted of 6.3 eggs. The peak of hatch occurred during the period of July 2 to 12.

Calif. Dept. Fish and Game, Sacramento, Calif.

SUPPLEMENT

Problems Affecting Application

Agricultural Research Service. SYSTEMIC CHEMICALS FOR CROP-INSECT CONTROL. U.S. Dept. Agr., Agr. Res. Serv. ARS 22-61. 1960.

Systemic insecticides provide one more way of fighting crop insects. This report is intended to give agricultural leaders background information on systemic insecticides for crop-pest control. Systemics are defined, their potentials and limitations discussed, and a look into the future attempted.

PRINCIPAL SYSTEMIC INSECTICIDES

(This list includes systemics that are still in the investigational stage as well as those registered for specific uses)

Current Name	Synonyms	Features
demeton	Systox (a mixture of thiono- and thiol-isomers)	Controls sucking insects on vegetables and fruits, also acts as a systemic-contact insecticide and fumigant against various insects.
dimefox	Pestox 14	Dimefox is highly toxic. It is manufactured and marketed abroad. Authorization has not been obtained for its public use in this country, and our researchers have shown limited interest in it.
Di-Syston	Bayer 19639	This promising insecticide, especially for seed treatment, controls not only sucking insects (including the eriophyidmite, carrier of peach-mosaic virus), but also some chewing insects such as grasshoppers. It controls the spotted alfalfa aphid on alfalfa and aphids, spider mites, and thrips on cotton. It is also used as a soil drench.
methyl demeton	meta-Systox	This moderately toxic chemical has largely been abandoned in favor of demeton, a more effective and more toxic systemic.
phorate	Thimet (American Cyanamid 3911)	Good systemic for specialized use, including some seed treatments.
Phosdrin	Shell OS-2046	This is a short-lived insecticide usable on leafy vegetables within 3 days of harvest. It is also used to control aphids on strawberries and the red-banded leaf roller on apples. It must be applied with the greatest caution.
phosphamidon	Cal. Spray Co. OR-1191 (ML-97)	This promising experimental chemical is effective against several chewing as well as sucking insects.
schradan	OMPA, a 40-per-cent ingredient in the technical Pestox III	This systemic is largely used, in this country, on some greenhouse ornamentals and on English walnuts to control the walnut aphid.

ARS, USDA, Inform. Div., Washington 25, D.C.

National Agricultural Chemicals Association. OFFICIAL FDA TOLERANCES COMPLETE THROUGH DECEMBER 1, 1960. Natl. Agr. Chemical Assoc. News and Pesticide Rev. 19(2): 1-19. 1960.

This special issue of NAC News and Pesticide Review is the seventh annually revised listing of official tolerances for pesticide chemicals used in or on raw agricultural commodities, as established by the Food and Drug Administration, U.S. Department of Health, Education, and Welfare.

Many uses of pesticides leave no residues on food crops at the time of harvest when the pesticides are used strictly in accordance with Federally registered label directions. Where no residues result from a certain use of a pesticide, it is not necessary to obtain a formal tolerance.

This compilation lists only those pesticide chemicals and crops on which tolerances have been established by FDA.

To be sure that your crop will be safe for shipment, follow these three simple rules: (1) Use a pesticide only on a crop for which it is recommended on the label; (2) use only the quantity of pesticide called for by the label; and (3) apply the pesticide at the time recommended on the label.

This issue also contains a list of pesticide by common, chemical, and/or trade name, and a alphabetical index by commodity.

Natl. Agr. Chemicals Assoc., Washington 6, D.C.

Claborn, H. V., Radeleff, R. D., and Bushland, R. C. PESTICIDE RESIDUES IN MEAT AND MILK: A RESEARCH REPORT. U.S. Dept. Agr., Agr. Res. Serv. ARS 33-63, 46 pp. 1960.

Studies were conducted at Kerrville, Tex., to determine whether insecticides used on livestock or on pasture and forage crops will contaminate meat or milk, and if residues are produced, how long they will persist.

Single spray treatments of DDT, TDE, and methoxychlor applied at 0.5 percent concentrations to beef cattle caused storage of the insecticide in the fat. Lindane at a concentration of 0.03 percent could not be detected, but at a concentration of 0.075 percent both sprays and dips caused residues in the fat. Multiple-spray treatments with lindane and methoxychlor at 3-week intervals caused no greater storage in the fat than a single treatment. Multiple treatments at 2- or 3-week intervals with other chlorinated hydrocarbon insecticides--chlordane, gamma chlordane, DDT, dieldrin, heptachlor, TDE, Strobane, and toxaphene resulted in slight-to-moderate increases in the amount of storage. A 0.5 percent malathion spray applied at weekly intervals caused no storage in the fat.

When insecticides were fed to beef cattle and sheep as a contaminant of their feed at dosages likely to occur as residues on forage crops, all except methoxychlor were stored in the fat. The order of their storage was as follows: aldrin > dieldrin > heptachlor epoxide > BHC > DDT > chlordane > lindane > endrin > heptachlor > toxaphene.

All the chlorinated hydrocarbon insecticides, Co-Ral, and malathion were excreted in the milk of dairy cows following the spray treatments. Rotenone was not excreted in the milk and Co-Ral was present in very small amounts. Dieldrin caused the greatest contamination followed in order by DDT, TDE, Dilan, toxaphene, Strobane, methoxychlor, Perthane, malathion, and Co-Ral. When Sevin, dicapthon, and Bayer 22408 were fed to dairy cows as a contaminant of their feed at dosages in excess of those likely to occur on forage crops, residues of these insecticides were not detected in the milk.

Tables.

ARS, USDA, Inform. Div., Washington 25, D.C.

Shaw, W. M., and Robinson, B. PESTICIDE EFFECTS IN SOILS ON NITRIFICATION AND PLANT GROWTH. Soil Sci. 90: 320-323. 1960.

Nitrification and plant growth experiments were conducted to determine the effect of the more common organic pesticides in two soil types. Insecticides aldrin and heptachlor, at rates of 10 to 100 lbs. per acre; chlordane, 30 to

300 lbs.; and herbicide 2, 4-D, at 10 to 100 lbs., in a Cumberland sil showed no inhibition of nitrification. The growth of Sudangrass and tomato plants on this soil was unaffected by the aldrin and heptachlor treatments. Growth on the chlordane treatment suffered small depressions at the 120- and 180-lb. rates, and a severe setback at the 300-lb. rate. All plants died on the 2, 4-D treatments.

None of the pesticide treatments on the Hartsells sl showed any ill effect on soil nitrification. The growth of corn and tomato plants showed slight decreases on the 150- and 200-lb. aldrin, dieldrin, and DDT treatments, and a significant decrease on the 200-lb. heptachlor and 120-lb. chlordane treatments. Corn growth was reduced by the simazin treatments beyond the 10-lb. rate, and there was practically no growth of the tomato plants on any of the simazin treatments. Unexplained significant increases in nitrate and plant growth on the insecticide treatments up to 100-lb. rates over that from the control were noted, but were not considered as interfering with the basic conclusions drawn from the data. The growth of tomato plants in the second year after treatment showed essentially the same response as in the first year.

U. Tenn., Agr. Expt. Sta., Knoxville, Tenn.

Agriculture Research Service. THE NATURE AND FATE OF CHEMICALS APPLIED TO SOILS, PLANTS, AND ANIMALS. U.S. Dept. Agr., Agr. Res. Serv. ARS 20-9, 221 pp. 1960.

This publication contains the papers presented at a symposium on agriculture chemicals, sponsored by the Agricultural Research Service, U.S. Department of Agriculture, and held at Beltsville, Maryland, April 27-29, 1960.

Symposium speakers discussed new developments in research dealing with agricultural chemicals; the responsibilities of Federal agencies and industry in assuring the safety of chemicals used in producing, processing, and distributing foods; and the potentials for solving current problems in this field through the joint efforts of scientists, regulatory workers, and the chemical and food industries.

ARS, USDA, Inform. Div., Washington 25, D.C.

Hunt, E. G., and Bischoff, A. I. INIMICAL EFFECTS ON WILDLIFE OF PERIODIC DDD APPLICATIONS TO CLEAR LAKE. Calif. Fish and Game 46: 91-105. 1960.

A study is being made of the effects on wildlife of DDD used in gnat control programs at Clear Lake, Lake County, California. The study began in May, 1958, and is being continued.

This paper is based on chemical analysis of animal tissue of specimens collected at Clear Lake and on information obtained during field investigations in that area.

Conclusive results obtained during the study were: (1) All fish, bird, and frog samples analyzed contained DDD; (2) the amount of DDD found in all flesh samples exceeded the specified rate of dilution of active insecticide in the lake water on a p.p.m. basis; (3) flesh samples of largemouth bass and Sacramento blackfish hatched between seven and nine months after the last DDD application contained 22 to 25 p.p.m. and 7 to 9 p.p.m. of DDD, respectively; and (4) all areas of the lake contained DDD contaminated fish.

Conclusions based in part on circumstantial evidence were: (1) Grebe losses occurring after DDD applications were caused by chronic DDD poisoning; (2) the nesting population of grebes at Clear Lake has declined as a result of DDD treatment of the lake; (3) certain species of fish possess a greater tolerance for DDD than do grebes; and (4) because of a difference in food habits carnivorous fish accumulated a greater amount of DDD than did plankton eating fish of the same size.

Calif. Dept. Game and Fish, Sacramento, Calif.

Entomology Research Division. THE SUGARCANE BORER: HOW TO CONTROL IT. U.S. Dept. Agr. L. 479, 8 pp. 1960.

The sugarcane borer is described and methods for control by the use of culture, insecticides, and resistant varieties are recommended for sugarcane, corn, and rice.

ARS, USDA, Inform. Div., Washington 25, D.C.

Fleming, W. E. THE JAPANESE BEETLE: HOW TO CONTROL IT. U.S. Dept. Agr. Farm. B. 2151, 16 pp. 1960.

A description of the Japanese Beetle is given along with the recommended methods of control in lawn, pastures, and gardens by spraying or dusting, hand collection, trapping, culture, and natural.

ARS, USDA, Inform. Div., Washington 25, D.C.

Willrich, T. L., and Baumann, E. R. QUALITY AND TREATMENT OF POND WATER. Trans. ASAE 3(1): 1-4, 8. 1960.

Farmers and other rural dwellers are using water of inferior quality. The use of contaminated water presents a serious health problem. Many pathogenic organisms are water-borne. These organisms may cause disease in man or animals or both. Few users of pond water are attempting to adequately treat the water to make it safe for human consumption.

The contaminated water also carries many food-spoilage organisms which cause a reduction in milk and food quality when the water is used in food processing. The permissible storage life of home-processed frozen foods is materially reduced by food-spoilage organisms.

To determine the extent of the problem and the most effective and practical methods and equipment for water treatment, a field study was begun in 1954. The authors concluded that:

1. All pond water supplies and the majority of well-water supplies are contaminated. Water-borne pathogens are a health menace. Food and milk spoilage organisms cause economic losses. Therefore, rural water supplies should be treated to destroy undesirable organisms.
2. Color and turbidity in newly constructed ponds varied from 1000 to 1500 units and 165 to 260 units, respectively. Color and turbidity in older ponds with vegetated slopes and predominately grassed watersheds were generally in the range of 10 to 50 units and 2 to 35 units, respectively. Filtration will generally be required to reduce color and turbidity. Treatment of the pond with gypsum will reduce color and turbidity.
3. Hardness of pond water samples taken near the top of the pond has generally between 25 and 130 mg/l, but water withdrawn from the side or near the bottom of the pond occasionally exceeded 300 mg/l in hardness.
4. Iron content of pond water varied from 0 to 0.3 mg/l. Usually no treatment will be essential for the removal of either iron or hardness from pond water.
5. The pH of pond water usually varied from 6.5 to 8.2, which is a satisfactory range for chlorination.
6. Pond water generally contained a nitrate concentration less than the amount considered dangerous to health. Nitrate concentration was highest in newly constructed ponds.
7. Water color, turbidity, hardness, and bacterial concentration were lowest near the pond surface. This water also is more palatable due to a lower taste and odor level.
8. Permanently submerged filters or filter entrances cannot be easily and effectively cleaned and maintained.
9. A vertical, slow-sand filter as a separate structure outside of the pond was easiest to operate and maintain.
10. A slow-sand filtering rate of approximately 50 gal. per day per square foot of filter area was effective in removing excess turbidity from pond water.
11. Rapid-sand filters required more frequent attention and greater skill in operation than slow-sand filters.
12. Sand filters improved the bacteriological quality of pond water, but did not consistently produce water which tested safe according to standard methods.
13. Properly and effectively operated, a superchlorination-dechlorination system will reduce the number of organisms present in water and

may provide a safe and palatable water supply. When a 3.0 mg/l residual was maintained practically all coliform-like bacteria and those bacteria which normally cause milk or food spoilage were eliminated.

14. Heat treatment by the hot water heater destroyed many bacteria without the addition of chlorine. With chlorination, the hot water generally contained the least number of bacteria.
15. Many operators of chlorination equipment are negligent in maintaining a chlorine supply and detecting equipment malfunction.

Iowa State U., Ames, Iowa.

DeForest, S. S. DEVELOPMENT OF A FENCE ERECTING MACHINE. Agr. Engin. 42: 66-67, 88. 1961.

Historically, fence building is an arduous, time consuming, uninteresting, costly, but necessary chore on livestock farms. Although there are many devices that will do part of a fence-building job and eliminate some of the labor, there was no known equipment that would do the complete fence-building job which our company believed was necessary. It was felt that a machine for this purpose should have the following minimum requirements: (1) It should be based on or built around adaptable equipment already in production; (2) it should operate over most of the usual types of farm land; (3) it should handle most of the types of fencing--including woven wire, multiple strands of barbed wire, and a combination of these--and steel or wood posts, corners, and end assemblies; (4) it should erect posts and fence in a single operation; (5) it should erect fence on an existing line of posts; (6) it should stretch barbed and woven wire simultaneously; (7) it should be designed for use with regular farm tractors, commonly equipped; (8) it should carry a reasonable supply of line posts, corners, and end assemblies; (9) it should not damage or deform fence materials; and (10) it should be safe to use and demonstrate.

To meet these minimum requirements, a fence erection machine was developed and tested that acted as a post driver, hoist, and dispensing and stretching equipment combined in one operating unit.

The experience with the demonstration fence-erection machines has shown that the concept of mechanical fence erection is sound and certainly long overdue. It is an important agricultural development--one that will enable farmers to lower production costs by fully participating in farming systems to make maximum utilization of land best suited for pasturing or grazing purposes, thus maintaining or increasing profits.

United States Steel Corp., Pittsburg, Pa.

McDowall, F. H., and Thomas, R. H. DISPOSAL OF DAIRY WASTES BY SPRAY IRRIGATION ON PASTURE LAND. Pollution Advisory Council P. 8, 94 pp. 1961.

Residues of dairy products in waste waters discharged from dairy factories have a high biochemical oxygen demand and are highly putrescible. When delivered to natural waters, they can cause heavy growths of sewage fungus, and lowering of the oxygen content of the water to levels at which fish cannot survive. At these low oxygen levels, also, putrefactive decomposition can occur, with the resultant production of "nuisance" conditions in and around the natural water.

The grouping of dairy manufacturing into larger units, through the consolidation of dairy companies and the use of tankers for collection of milk over a wider area, is leading to discharge of greater concentrations of wastes in particular localities.

The only dairy liquid discarded from dairy factories in large quantities in undiluted form is whey, which is produced as a by-product of both cheese and casein manufacture. The content of putrescible matter in a dairy wastes discharge can, therefore, conveniently be expressed in terms of the whey equivalent, computed from the known average BOD_5 values for the various dairy products.

Dairy wastes can be purified in treatment plants of the type used for the handling of domestic sewage. For wastes containing any considerable proportion of whey the costs would be prohibitive.

The only economically feasible method for disposal of concentrated wastes, other than direct utilization for som than direct utilization for some purpose, such as pig feeding, is irrigation on pasture land. Irrigation, if it can conveniently be arranged, is also probably the most suitable method for the disposal of dilute wastes. On suitable areas the wastes may be irrigated by flooding or by border diking, but the most efficient method of distribution of the wastes on the pasture is by spraying.

The maximum dose of strong waste appears to be about 10,000 gallons of whey or whey equivalent per acre once every 14 days. In designing an irrigation installation for dairy wastes it is safer to allow for a dosage rate lower than the maximum, within the range 5,000-8,000 gallons of whey equivalent per acre every 14 days. For weaker wastes the capacity of the soil to take up the volume of liquid without run-off is the main criterion in design and the application rate must be selected to suit the prevailing weather conditions and the type of soil being irrigated.

The best area for spray irrigation of wastes is on flat land, with a fairly porous soil and subsoil.

Dairy wastes improve the fertility of the soil on which they are irrigated. The useful available elements in the wastes are phosphorus, potassium, calcium, magnesium, and nitrogen. Excess sodium in the wastes, on the other hand, either as common salt or as alkaline cleansers, may cause deterioration of the physical condition of the soil. This may be overcome by application of lime to the area. During dry seasons the irrigating effect of the water in the wastes may be a valuable aid to the maintenance of good growth of the pasture.

Pollution Advisory Council, P.O. Box 2395, Wellington, New Zealand.

Soil-Plant Relationships

Smika, D. E., Haas, H. J., and Rogler, G. A. YIELD, QUALITY, AND FERTILIZER RECOVERY OF CRESTED WHEATGRASS, BROMEGRASS, AND RUSSIAN WILDRYE AS INFLUENCED BY FERTILIZATION. J. Range Mangt. 13: 243-246. 1960.

This study involved seven commercial fertilizer treatments (30-0-0, 30-30-0, 30-30-30, 60-0-0, 60-60-0, 60-60-60, and 90-0-0 lb. of N - P_2O_5 - K_2O per acre, respectively); one barnyard manure treatment (15 tons per acre); and one no-fertilizer treatment (0-0-0). There were two randomized replications of each. The fertilizers were broadcast annually in late fall, except in the first and fourth year, when they were broadcast in the spring. The grasses used in this study were crested wheatgrass (Agropyron desertorum (Fisch.) Schult.); Russian wildrye (Elymus junceus Fisch.); and bromegrass (Bromus inermis Leyss.).

Herbage samples were collected and analyzed for nitrogen and phosphorus to determine protein and phosphorus content.

Yield increases from fertilizers for all grass species were largely attributed to nitrogen alone. Phosphorus in combination with nitrogen resulted in yields slightly greater than were obtained from the nitrogen alone treatments, but the differences were not significant. Fifteen tons of manure was approximately equal to 30 lbs. of nitrogen for increasing yield.

The greatest increase in protein content of the grasses occurred when nitrogen fertilizer was applied alone. Phosphorus, in combination with nitrogen fertilizer, decreased the percentage protein in most instances below that of the nitrogen alone treatment. When 15 tons of manure were applied, the protein content of the grass was nearly equal to that which received 30 lbs. of nitrogen.

The phosphorus content of the hay was generally reduced as the rate of nitrogen alone applications increased. Phosphorus, at the 30-lb. rate, in combination with nitrogen, increased the phosphorus content of the hay to above the non-fertilized level except for crested wheatgrass. Sixty lbs. of phosphorus gave small or no increase above the percentage obtained by the 30-lb. application, but did increase the phosphorus content of crested wheatgrass to that of the non-fertilized level. Fifteen tons of manure increased the phosphorus content of the hay of all three species more than any other treatment.

The greatest percentage recovery of applied nitrogen was made by crested wheatgrass. Successive years of fertilization had no effect on the percentage recovery of the applied nitrogen, but in years of cooler temperature, recovery was increased.

SWCRD, ARS, USDA, Mandan, N. Dak.

Smith, D. YIELD AND CHEMICAL COMPOSITION OF OATS FOR FORAGE WITH ADVANCE IN MATURITY. Agon. J. 52: 637-639. 1960.

Analyses of oat forage indicated that the percentages of protein, fat, ash, P, Ca, K, and nitrate declined from early growth to maturity while the percentage of nitrogen-free extract increased. The percentage of fiber increased until the heads were emerging from the boot and then decreased.

The yields per acre of dry matter and of protein, ash, P, and Ca, constituents important to animal nutrition, increased steadily to a stage of growth when the seeds were nearly ripe and then decreased. However, a high proportion of the total yield per acre of protein, ash, P, and Ca was produced at early dough, the stage of growth often indicated as the best stage to harvest for hay or silage.

Wis. Agr. Expt. Sta., Madison, Wis.

Elder, W. C. GRAZING CHARACTERISTICS AND CLIPPING RESPONSES OF SMALL GRAINS. Okla. State U. B. B-567, 15pp. 1960.

Several different grazing and clipping trials with small grain winter pastures were conducted during the period 1953-4 through 1958-9. The principal pasture used was a mixture of rye, winter oats, and vetch.

In a 6-year test of production as measured by gains of short yearling beef heifers (400 to 500 lbs. when grazing was started), animals grazing throughout the season gained an average of 1.54 lbs. per head daily. Annual gain per acre average 233 lbs. Pasture was available an average of 140 days per season. Gain per acre varied less than pasture days per season; if fall growth was small, more animals were needed to make full use of the heavy spring growth. Carrying capacity averaged 1.08 head per acre. Time of starting grazing varied with planting date, which in turn varied September rainfall; it ranged from October 25 to March 9. Amount of forage growth by November 1 was a good indicator for estimating carrying capacity for the rest of the season.

Irrigated and dryland pastures were compared during three seasons. Irrigation insured establishment in time for fall grazing. Beef production was doubled by irrigation plus 150 lbs. of actual nitrogen per acre as compared to dryland pasture without nitrogen. Irrigation was seldom needed in winter or spring.

Rotation grazing increased animal gain per acre by 14 percent.

Clipped forage yields were obtained on irrigated pasture during four seasons, for two heights and four frequencies of clipping. At the 2-inch height, clipping every 30 days increased yields 27 percent over the 15-day interval. Small grains were injured severely by early clipping.

Six planting dates were compared during four seasons, using clipped forage yields as a measurement. Plantings on September 10, September 25, and October 10 gave the same total production for the year. However, the September 10 date produced twice as much forage before January 1 as did the October 10 planting. Seeding later than October 25 eliminated all possibility of pasturing before March. One day's growth in September was equal to around five to ten days in the winter months.

Elbon rye with vetch produced 50 percent more animal gain than Balbo with vetch from November through January in a four year comparison. Total annual gain was the same for both varieties because the Balbo and vetch had a higher carrying capacity in April and early May.

Agr. Expt. Sta., Okla. State U., Stillwater, Okla.

Romney, E. M., Ehrler, W. L., Lange, A. H., and Larson, K. H. SOME ENVIRONMENTAL FACTORS INFLUENCING RADIOSTRONTIUM UPTAKE BY PLANTS. Plant and Soil 12: 41-48. 1960.

The amounts of Sr-90 taken up from Vina soil varied among several different crop plants by a factor as high as 10 on the basis of dry weight. The relative decreasing order of Sr-90 uptake by mature plant tops was turnip = millet>Swiss chard > Ladino clover > broccoli > soybeans>barley oats>wheat>spinach. For each of the cereal crops, the concentration of Sr-90 in the grain was only about one-fifth of the Sr-90 in the forage. The tubers of White Rose potato grown on Sassafras, Hanford, and Sorrento soils contained only about one-fiftieth of the Sr-90 concentrated in the tops. The Sr-90 uptake by potato was inversely correlated with the level of plant-available calcium in Sassafras, Hanford, and Sorrento soils.

Lowering of root temperature from 17° to 7°C. significantly reduced Sr-90 uptake by barley and beans during a 24-hour absorption period. Q10 values indicated that strontium uptake was chemically controlled rather than the result of physical phenomena.

A decrease in light intensity from 1,000 to 450 foot-candle significantly reduced Sr-90 uptake by barley and beans. The uptake of Sr-90 also was reduced as the light exposure period was decreased One-third to one-half of the total amount of Sr-90 obtained during a 24-hour absorption period was taken up independent of exposure to light.

School of Medicine, U. Calif., Los Angeles, Calif.

McLean, E. O., Arscott, T. G., and Volk. V. V. ADSORPTION AND RELEASE OF STRONTIUM FROM CLAYS AND SOILS WITH EQUILIBRATION, ISOTOPIC TRACER AND PLANT UPTAKE TECHNIQUES. Soil Sci. Soc. Amer. Proc. 24: 452-457. 1960.

The percentages of Sr-90 adsorbed by bentonite and illite clays when saturated to various degrees with the complementary ions H, Ca, Ba, and K were determined. The percentages of Sr-90 taken up in an 8-hour period by soybean plants from the above systems as well as from solutions containing the same total concentrations of the cations as the clays were also computed. The amounts of Sr absorbed by a soil containing various levels of exchangeable Ca (established by prior rates of liming in the field) were measured by equilibration with $SrCl_2$ solutions. Sr was generally adsorbed less and taken up by plants more from illite than from bentonite. Addition of Ca or Ba as compared to H decreased Sr adsorbed and increased Sr uptake by plants from the clays, thus having the effect of accelerating the decontamination of the clays by cropping. Sr appeared to be bonded by bentonite but not by illite with sufficient energy to restrict its uptake by soybeans. Increased level of exchangeable Ca in a soil did not appreciably affect the amounts of Sr adsorbed from $SrCl_2$ solutions.

J. Article 4-60, Ohio Agr. Expt. Sta., Wooster, Ohio.

Bryant, E. A., Cowan, G. A., Heald, W. R., Menzel, R. G., Reitemeier, R. F., Sattizahn, J. E., and Warren, B. BIOLOGICAL AVAILABILITY OF STRONTIUM-90 FROM ATOMIC TESTS. Sci. 132 (3423): 327-330, Aug. 5, 1960.

Strontium-90, produced by nuclear explosions, has received considerable attention as a potential hazard to human life. The suggestion has been made by W. F. Libby that this hazard might be reduced if nuclear explosions were conducted in a manner such that strontium-90 is incorporated in insoluble particles and is thus made unavailable to living organisms. Such incorporation would have to take place in the bomb cloud during the time required for condensation and solidification of the volatilized material. Since krypton-90, a gaseous predecessor of strontium-90, decays with a half-life of 33 seconds, the relevant time scale for condensation includes the first several minutes following detonation. Very little is known about physical conditions in a bomb cloud during this period. However, visual observations indicate that condensation of the main body of the debris occurs during the first minute, even for megaton explosions.

The experiments described provide data concerning the solubility and biological availability of strontium-90 in samples collected from the airborne debris from devices which were exploded in a number of different environments. The experiments were designed not only to provide information on the incorporation of strontium-90 in relation to device yield and matrix material, but also to establish a simple test for strontium-90 availability as a parallel to the classical ammonium acetate method for determination of the exchangeable calcium content of soil.

The most encouraging data came from test number 8, an air burst with a matrix of aluminum and iron. The solubility of the strontium-90 in debris from this test was only 0.52 after exposure to water for more than a year. The 0.52 solubility of the strontium-90 observed for test number 8 is consistent with complete incorporation of the rubidium-90 and strontium-90 present in the fireball 20 seconds after the explosion. The data from test number 8 indicate that a small amount of material can incorporate strontium-90 in an insoluble form, provided that the fireball stays hot long enough for the krypton-90 to decay.

U. Calif. Los Alamos Sci. Lab., Los Alamos, N. Mex.

SOIL SURVEYS

Genesis and Morphology

Permian Subcommittee of the National Research Council's Committee on Stratigraphy. CORRELATION OF THE PERMIAN FORMATIONS OF NORTH AMERICA. Geol. Soc. of Amer. B. 71: 1763-1806. 1960.

The chart indicates the present stratigraphic classification of the Permian rocks in each important area of outcrop in North America and the time relations of the deposits in the several areas as now understood. Annotations in the text suggest the evidence for many of the correlations and point out unsolved and controversial problems.

Chart, annotations, and bibliography, in addition to text.

No address given.

Wilson, C. W., Jr., and Stearns, R. G. PENNSYLVANIAN MARINE CYCLOTHEMS IN TENNESSEE. Geol. Soc. Amer. B. 71: 1451-1466. 1960.

In contrast to prevailing concepts, Pennsylvanian (Pottsville) sedimentary rocks of Tennessee, except for coals and adjacent strata, are considered to have been deposited in marine water of considerable depth.

Blanket sandstones, restricted to the lower third of the column, were deposited by southwestward-moving currents in a shallow (i.e. tens of feet deep) arm of the sea, which was greatly restricted by Appalachia to the southeast and the emergent Cincinnati arch to the northwest. Digitate sandstones occur in the upper beds and extend westward partly across the coal field. These digitate sandstones were deposited on the east flank of the Interior Sea where sediment-laden water moved down the slope into deeper water; each tongue may have matched a stream mouth which had its headwaters in Appalachia. At this time the Cincinnati arch was buried. Shale blankets were deposited in deep, quiet water. Widespread coal zones mark periods of abrupt withdrawal of the sea.

On the assumption that the bulk of the strata are marine, the writers have applied the concept of four-phase cyclothem deposition and divided the lower third of the column into five cyclothems. Phase 1 is commonly represented by coal beneath blanket sandstones. Phase 2 is represented by a widespread marine sandstone blanket deposited in shallow water; local coals within these sandstones indicate local filling up of the shallow sea by rapid sedimentation adjacent to Appalachia. Phase 3 is represented by the widespread coal zone in normal position above the blanket sandstones. Phase 4 is represented by a widespread shale blanket deposited in a deep sea. Stratigraphic cross sections and paleogeographic block diagrams illustrate each phase.

Vanderbilt U., Nashville, Tenn.

Nichols, R. L. GEOMORPHOLOGY OF MARGUERITE BAY AREA, PALMER PENINSULA, ANTARCTICA. Geol. Soc. Amer. B. 71: 1421-1450. 1960.

A snow-covered plateau hundreds of miles long extends from the northern to the southern part of the Palmer Peninsula, Antarctica. It is approximately 2000 feet high at the northern end and more than 6000 feet high at the southern end. The plateau presumably is a middle or late Tertiary peneplain which has been differentially uplifted. The peneplain was dissected after the uplift; depression of more than 1000 feet since then has resulted in a shore line of submergence.

Wright, Priestley, and Gould thought that glaciation started in the Antarctic in the middle Tertiary because they interpreted breccias as tillities. The writer concludes after an examination of the literature that these breccias are probably volcanic; he believes that there is no good evidence for Tertiary Antarctic glaciation.

U-shaped valleys, cirques, horns, truncated spurs, arêtes, glacially formed bedrock basins, erratics, and moraines are common.

Evidence of deglaciation is widespread. Land ice extended more than 15 miles beyond the present strand line during the most advanced stage of glaciation. Three thousand feet of ice covered areas now deglaciated. The southwest terminus of the shelf ice in King George VI Sound retreated approximately 30 miles from 1940 to 1949. The Northeast Glacier retreated measurably from 1940 to 1947.

A strand flat 1500 feet long, 400 feet wide, and in places as much as 20 feet above sea level was mapped. Till buried in places by elevated beach gravels veneers its bedrock platform. The strand flat was formed by a local glacier. Since its formation, sea level has dropped as much as 20 feet with respect to the land. Other strand flats have had a somewhat similar history.

More than 20 elevated beaches were studied. The highest is approximately 110 feet above sea level. Elevated beaches have also been reported from South Victoria Land and from the northern part of the Palmer Peninsula The elevations of these beaches suggest that on the average more than 300 feet of ice has been removed from the margin of the continent during deglaciation.

The average depth of the break in the slope of the Antarctic continental terrace is approximately 1600 feet. The world average depth of the break in slope is approximately 430 feet. If the great depth of the Antarctic break in slope is due solely to the weight of the icecap, the icecap must average between 3550 and 4800 feet thick.

More than 75 percent of the area is covered with permanent ice. Valley, piedmont, tidewater, cliff, cirque, reconstructed, outlet, transection, and fringing glaciers are common; so too are highland, snowdrift, shelf, and island ice.

The insignificant quantity of alluvium and the small size of the meltwater streams in the summer months prove that running water is of only minor importance as a geologic agent.

Tufts U. Medford, Mass.

Taubeneck, W. H., and Poldervaart, A. GEOLOGY OF THE ELKHORN MOUNTAINS, NORTHEASTERN OREGON: PART 2 WILLOW LAKE INTRUSION. Geol. Soc. Amer. B. 71: 1295-1322. 1960.

The Willow Lake intrusion is funnel-shaped with contacts inclined inward at 60°-70° and has a sheetlike appendage to the southwest, inclined northwest at 50°. The pluton lies athwart the southern contact of the Bald Mountain batholith and was emplaced before the main batholithic phases. It contains normal metagabbroic rocks, rhythmically layered rocks similar to those described from the Stillwater and Skaergaard intrusions, and abnormal banded rocks in which the minerals are elongated and arranged with their longer axes at high angles to the banding. Similar abnormal banded rocks have been found in a number of localities in Oregon and California, invariably in steep-walled intrusions of small size, including dikes a foot or less in width. The Willow Lake type of rhythmical layering could not have been formed by a process combining gravitative sedimentation of crystals with convection currents in the magma, such as accounts for Skaergaard-type layered rocks. The Willow Lake-type layered rocks probably formed by undercooling and crystallization in the oversaturated (metastable) region, combined with intermitten convective and turbulent currents, in a magma near a univariant condition.

Banded rocks of this type may be expected in epizonal metamorphic regions in steep-walled mafic intrusions, emplaced late in the regional metamorphic cycle. Criteria for so-called gravity stratification are examined; the various features of density stratification may in part be due to processes other than those operating under the influence of gravity. The perpendicular feldspar rock of the Skaergaard intrusion and the harrisite structure of layered periodotities from the island of Rhum are cited as products of moderate undercooling of magma in a bivariate condition. Translation-gliding effects and a set of conjugate shears developed in Willow Lake banded rocks are attributed to stresses in the crystal mush resulting from magma movements past surfaces of crystallization. The role of diffusion in the interstitial melt is discussed, and the formation of monomineralic layers in the Willow Lake banded rocks is attributed to diffusion between interstitial melts of adjacent bands of contrasting mineralogy and reactions between the melts and the surrounding solid phases.

Oreg. State U., Corvallis, Oreg.

Orville, P. M. PETROLOGY OF SEVERAL PEGMATITES IN THE KEYSTONE DISTRICT, BLACK HILLS, SOUTH DAKOTA. Geol. Soc. Amer. B. 71: 1467-1489. 1960.

Three pegmatites in the vicinity of Keystone, South Dakota, of simple mineralogy and without concentric zoning have been studied in detail. They occur within Precambrian Quartz-mica schist and are peripheral to the Precambrian Harney Peak granite. Two are concordant to schistosity and bedding of the country rock, and the third is sharply discordant. These pegmatites are of very similar average modal and chemical compositions. Samples of the Harney Peak granite from two localities have compositions close to those of the pegmatites. All the compositions fall near the quartz-feldspar field boundary in the "synthetic-granite" system. The average composition of pegmatites and granite is approximately 30 percent quartz, 44 percent plagioclase, 17 percent microcline, 8 percent muscovite, and less than 1 percent tourmaline, garnet, and apatite.

Large perthite crystals appear to have grown, at least in part, by pushing aside previously crystallized fine-grained quartz and plagioclase. This relationship is compatible with experimental findings which indicate that in a melt of this composition, crystallization, whether of the one- or two-feldspar types, should begin with quartz and a Na-rich feldspar.

At one locality thin, steeply dipping tabular pegmatites are sharply separated into an upper porphyritic perthite-bearing unit and a lower fine-grained albite-quartz unit. The upper, perthite-bearing unit of the layered pegmatites has a composition near that of the "granite Minimum" in the "synthetic-granite" system and is thought to represent a rest liquid which has been separated from the phases which crystallized earlier.

The pegmatites and granite are believed to have been intruded as magma derived from a common source.

Vanderbilt U., Nashville, Tenn.

Wurman, E. PEDOGENIC AND PETROGENIC CHARACTERISTICS OF SOIL PROFILES DEVELOPED IN SILT-MANTLED ACID SHALE. Soil Sci. 90: 348-356. 1960.

Two soil profiles (El Paso sil, and El Paso, shallow varient) developed in silt-mantled acid shale were described in the field and analyzed in the laboratory. Results point to the major role that underlying geologic materials sometimes play in determining solum characteristics. This suggests the need for including continuous changes in subsurface materials--by interaction with the atmosphere, as reflected in direct or indirect influences in overlying sola--with the general grouping of soil-formation processes. The materials so affected should thus be regarded as an integral part of the soil. It is suggested that the application of the genetic soil horizon nomenclature advocated be indicated by placing the proposed symbols in parenthesis after the soil horizon designations used in the profile descriptions.

Wisc. State Col., Madison, Wisc.

Harrison, W. ORIGINAL BEDROCK COMPOSITION OF WISCONSIN TILL IN CENTRAL INDIANA. J. Sedimentary Petrology 30: 432-446. 1960.

An attempt has been made to convert the mineral and rock-fragment components of a till into the original bedrock materials from which they were derived. The till used was a composite one (designated the "typical" till) that represented the averaged fraction-analysis data for 11 highly similar till samples from Marion County, Indiana. For this study it was assumed that: (1) The glacier flow unit that reached Marion County was 20 miles wide and coincided with a series of interconnected bedrock lowlands lying between northeastern Indiana and Lake Naococane, Quebec; (2) the flow unit eroded bedrock (or older drift) continuously throughout its journey from Lake Naococane; and (3) the different shales traversed by the ice were eroded equally.

In terms of volume-percent composition, the typical Wisconsin till in Marion County probably consists of about 33 percent shale, 29 percent metamorphic and igneous rock, 18 percent limestone, 16 percent dolomite, 2 percent sandstone and siltstone, and 2 percent miscellaneous rocks. Approximately 90 percent of the typical till may consist of bedrock from outcrops more than 100 miles upstream from the site of till deposition.

An approximate 1 to 1 relationship has been found between the weight percent of a given rock type in the typical till and the percent of outcrop area of that rock type upstream. Implications of this relationship are that: (1) The ice streams that developed the Marion County tills eroded materials according to a weight rule; (2) the tills were not deposited by lodgement processes; and (3) the ice streams picked up and transported bedrock for distances in excess of 1200 miles.

Col. William and Mary in Norfolk, Norfolk, Va.

Log, J. OBSERVATIONS ON SPECIAL COLOURS OF THE A_2- LAYER OF PODZOL SOILS IN NORWAY. Acta Agr. Scandinavica X 45-49. 1960.

The color of the A_2-layer of the podzol soils may be expected to vary with: (1) The intermixture of humus; and (2) the degree of weathering of the mineral material. In areas recently glaciated, as in the countries of Northern Europe, decomposition will be relatively small, and the mineral material's own color may here make itself felt in the A_2-layer.

A description is given of podzol soils in nordmarkite-ekerite mornainic material in the Oslo region, whose A_2-layer was of pink color.

Profiles in which the A_2-layer is darker than the B-layer occur in material of shale and phyllite. Podzol profiles with very dark gray A_2-layer have been found on the mountain plateau Hardangervidda, in soil material of phyllite. In some cases this layer had, in wet condition, to be characterized as black, according to Munsell color chart. The B-layer was of a yellowish red, brown, or strong brown color.

Agr. Col. Norway, Vollebekk, Norway.

Bretz, J. H. BERMUDA: A PARTIALLY DROWNED, LATE MATURE, PLEISTOCENE KARST. Geol. Soc. Amer. B. 71: 1729-1754. 1960.

During Pleistocene time, the Bermuda Islands repeatedly underwent partial inundation and re-emergence. The land areas were continuously attacked and reduced by rain and ground water but repeatedly renewed, during times of submergence, by deposition of marine limestone and by contemporaneous additions of shore-born and wind-transported carbonate sand, now eolianite. Soils formed under subaerial conditions are now buried beneath later deposits and constitute important stratigraphic markers. The igneous foundation rock appears to have been exposed during some low marine stands, and the former shore lines seem to be recorded by submerged terraces. The major karst features are largely below sea level, and they must date from times of continental glaciations.

Previous writers have assigned eolian accumulation to times of Pleistocene low sea level and soil-making to times of interglacial high sea. Both conclusions are held to be erroneous.

Dept. Geology, U. Chicago, Chicago, Ill.

Khan, D. H. CLAY MINERAL DISTRIBUTION IN SOME RENDZINAS, RED-BROWN SOILS, AND TERRA ROSSAS ON LIMESTONES OF DIFFERENT GEOLOGICAL AGES. Soil Sci. 90: 312-319. 1960.

A study was made of the distribution of clay minerals in some genetic soil types on limestones of different geological ages. The soil profiles belonged to rendzina, red-brown soils, and terra rossas, and were collected from England, Wales, France, and Spain. The underlying limestone sediments ranged from Carboniferous to Miocene (Tertiary) in age of formation; clay minerals in the non-carbonate residue of these limestones were also studied. The findings may be summarized as follows: (1) The montmorillonoid minerals are either absent altogether or present in a very small amount in limestone formations older than Cretaceous. Vermiculite was detected in limestone residues, sometimes in appreciable amounts. (2) Mica was found to be the dominant mineral in all the hard crystalline limestones (under study) which belong to geological ages older than Cretaceous, with the exception of one Miocene limestone. Kaolin was present in limestone in minor amount. (3) Rendzina clays were found to be essentially montmorillonitic, and terra rossa clays dominantly micaceous. Red-brown-soil clays were markedly characterized, however, by a high vermiculite content with some mica-kaolinite mixture. The intergrade soil clays had more abundant kaolin minerals than any other limestone soil clay. The iron oxide mineral detected in soil clays was goethite. And (4) an appreciable amount of decomposition of mica minerals occurred during soil formation on limestone, the process being more marked in red-brown and terra rossa soils. Formation of kaolin mineral, probably at the expense of mica, was found in different soils, and formation of vermiculite was found in red-brown soils and terra rossas.

Jute Res. Inst., Tejgaon, Dacca, East Pakistan.

Classification and Land Use

Soil Conservation Service. SOILS FOR WOOD-CROP PRODUCTION: SURVEYS; STUDIES; GUIDES; PLANS. U. S. Dept. Agr., Soil Conserv. Serv. SCS-CI-11, 8 pp. 1960.

Soil surveys, interpreted in terms of land capability and woodland suitability, are the basis for sound soil and water conservation plans and profitable wood-crop production from America's woodlands.

Soil information helps the woodland owner or forester make important decisions about woodland use and management. Soil surveys with interpretations for woodland conservation are useful in: (1) Acquiring land, or designating certain areas, for production of wood crops; (2) making choices among soils on which to grow specific wood crops; (3) adapting management operations to different kinds of soil based on their capability and limitations; (4) determining the economic feasibility of using land for wood crops and applying different cultural practices; and (5) applying needed soil and water conservation practices under the system of use and management selected.

SCS, USDA, Inform. Div., Washington 25, D. C.

Lutz, H. J., and Caporaso, A. P. VEGETATION AND TOPOGRAPHIC SITUATION AS INDICATORS OF FOREST LAND CLASSES IN AIR-PHOTO INTERPRETATION OF THE ALASKA INTERIOR. Alaska Forest Res. Cent. Sta. Paper 10, 31 pp. 1958.

Widespread and repeated forest fires have, in the past sixty years, destroyed great areas of forest in the Alaska interior. Classification of these burned lands into broad productivity classes--commercial forest land and land not capable of commercial wood production--involves use of all available criteria. Vegetation and topographic situation may be used by air photo interpreters as indicators or guides in recognizing these forest land classes.

White spruce is a fairly reliable indicator of commercial forest land. It is relatively sensitive to poorly drained, cold, wet soils and is usually absent from black spruce muskeg forests. Under white spruce the minimum depth to permafrost (if present at all) is generally 24-36 inches.

Black spruce is a characteristic muskeg tree in Alaska, usually occupying cold, wet, poorly drained soils. Permafrost is commonly only 12 to 20 inches below the top of the moss and lichen layer. Black spruce muskeg forest on north-facing slopes, at relatively high altitudes, and on land with a slope of less than 10 percent is not capable of commercial wood production.

The paper birches are associated with fair to good drainage conditions and commercial forest land. Under paper birch the minimum depth to permafrost (if it is present at all) is usually 36 to 48 inches.

Quaking aspen is a particularly useful indicator species. It is more sensitive to poorly drained, cold soils with permafrost at shallow depth than any other tree species in Alaska. The presence of aspen indicates that frozen ground, if present, is at least 48 inches below the surface. Quaking aspen is an excellent indicator of commercial forest land. The only exception is when the species occurs on over-steepened south-facing slopes of 60 percent, or more, gradient.

Balsam poplar, characteristically a species of river flood plains, is an indicator of commercial forest land. Where balsam poplar occurs permafrost is either absent or at least three to six feet below the surface.

Tall willows (20 or more feet in height) are believed to indicate land having the potentiality of commercial wood production.

Wet grass and sedge meadows occupy non-forest land.

The nature of the boundaries of vegetation types may be used in judging site conditions. Boundaries that follow contour lines usually indicate that the communities involved are under the control of ground water. Vegetation boundaries that do not follow contour lines, but cross them irregularly, usually represent edges of old burns. Type boundaries on slope faces that cross contour lines at approximately right angles are usually associated with erosional features. They may mean either shallow gullies or washes with better than average drainage or slight ridges with better than average drainage.

Slope exposure exerts a powerful influence on soil conditions, especially drainage and depth to permafrost, and forest vegetation in Alaska interior. South-facing slopes are usually most favorable for forest growth; north-facing slopes are usually least favorable. Slopes with an east or west exposure exhibit conditions intermediate between those found on south-facing and north-facing slopes. Within the permafrost region, north-facing slopes usually support black spruce muskeg forest and are incapable of producing crops of commercial wood. Over-steepened slopes (60 percent gradient, or more) having a southern exposure are too dry to support commercial forest stands. They are often treeless or bear a scattered growth of poor aspen. Land below the subalpine zone having a slope exposure of east, south, or west and a slope gradient of not less than 10 percent nor more than 60 percent may be regarded as commercial forest land.

Degree of slope is particularly important at low gradients (less than 10 percent) and at high gradients (more than 60 percent). When slope gradient falls below about 10 percent, soil drainage is impeded and frozen ground is commonly encountered at shallow depth (10 to 20 inches). Black spruce muskeg forest usually occupies such land. At high slope percentages (over 60), land having a southern exposure is too dry for normal forest growth.

In valley bottoms and other lowland situations soil drainage and depth to permafrost are the principal factors influencing forest growth. Situations where soils and substrata are coarse-textured and adjacent to well-established drainage ways represent commercial forest land. These conditions are found often along large streams with flood plains. Flat valley floors and other lowland situations without well-developed drainage-ways usually represent non-commercial forest land.

Alaska Forest Res. Cent., Juneau, Alaska.

Hockensmith, R. D. THE NATIONAL COOPERATIVE SOIL SURVEY IN THE UNITED STATES. U.S. Dept. Agr., Soil Conserv. Serv., SCS-TP-138, 10 pp. and maps. 1960.

A report and maps on the progress of the national cooperative soil survey in the United States and how the complete maps can be used.

SCS, USDA, Inform. Div., Washington 25, D. C.

SOIL CONSERVATION. 26: 99-111. 1960.

This issue of SOIL CONSERVATION has the following articles on the use of and value of soil surveys:

1. Williams, D. A. SOILS-THE KEY TO PROPER LAND USE. SCS, USDA, Washington, D. C.
2. Hockensmith, R. D. SOIL SURVEYS FURNISH BASIC DATA FOR ALL LAND USES. SCS, USDA, Washington, D. C.
3. Smith, V. W. A REALTOR'S VIEWS ABOUT SOIL SURVEYS. Washington, D. C.
4. Eikleberry, R. W. THEY LEARN ABOUT THEIR SOIL MAPS BY RESERVATION ONLY. SCS, USDA, Lincoln, Nebraska.

SCS, USDA, Inform. Div., Washington 25, D. C.

Soil Conservation Service. SOIL SURVEY AND VEGETATION: NORTHEASTERN KODIAK ISLAND AREA, ALASKA. U. S. Dept. Agr., Soil Conserv. Serv. 46 pp. Oct. 1960.

Soil Conservation Service. SOIL SURVEY: * U. S. Dept. Agr., Soil Conserv. Serv. **

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ORANGE COUNTY, FLORIDA.	63 pp. Sept. 1960.
FAYETTE AND UNION COUNTY, INDIANA.	91 pp. Sept. 1960.
BROWN COUNTY, KANSAS.	32 pp. Sept. 1960.
FREDERICK COUNTY, MARYLAND.	144 pp. Sept. 1960.
UPPER FLATHEAD VALLEY AREA, MONTANA.	67 pp. Sept. 1960.
ERIE COUNTY, PENNSYLVANIA.	119 pp. Dec. 1960.
DARLINGTON COUNTY, SOUTH CAROLINA.	89 pp. Oct. 1960.
BERYL-ENTERPRISE AREA, UTAH.	75 pp. Sept. 1960.
LOUDOUN COUNTY, VIRGINIA.	118 pp. Sept. 1960.
MASON COUNTY, WASHINGTON.	76 pp. Sept. 1960.
PAULDING COUNTY, OHIO.	95 pp. Oct. 1960.

These Soil Surveys are all published by the United States Department of Agriculture--Soil Conservation Service in cooperation with the local State agriculture and/or other cooperating agencies. All contain maps in addition to the written text.

SCS, USDA, Inform. Div., Washington 25, D. C.

Phillips, J. A., and Riecken, F. F. CHARACTERISTICS OF THE FLOYD AND SOME RELATED SOILS IN FLOYD AND BREMER COUNTIES, IOWA. Iowa Acad. Sci. 67: 277-289. 1960.

Imperfectly and poorly drained soils generally considered to have developed under prairie from a parent material consisting of a sandy-silt mantle overlying Iowan glacial loam till were studied. Three Floyd profiles, two profiles of the proposed Tripoli series (Floyd, poorly drained variant), and one Clyde profile were studied in the field and in the laboratory. Results indicate that the Tripoli soils should be separated from the Floyd and mapped as a separate series. The present concepts on the Floyd series as a minimal Brunizem and the Tripoli as a minimal Wiesenboden are substantiated by field studies and laboratory data.

Iowa State U., Ames, Iowa.

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Growth Through Agricultural Progress